THE INTERSECTIONALITY OF CLIMATE CHANGE: AGRICULTURE DEVELOPMENT AND ENVIRONMENTAL POLICY IN BRAZIL

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ABSTRACT

Globally, climate change is having significant effects on ecosystems and its services. In this context, food security is topping the list of concerns. For a country like Brazil, a leading agriculture producer, sustainability is key to ensure long-term prosperity. As the primary home of one of the world's most important ecosystems, the Amazon, Brazil has struggled to balance the economic benefits of agriculture development with the environmental impacts – namely deforestation. For many years, Brazil was viewed as an environmental steward when it successfully slashed deforestation rates through command-and-control environmental policy; however, as of late this trend is reversing. As climate action and discourse grows globally, it is important to take stock of how environmental policy has evolved in Brazil, how it has affected deforestation and the influence agriculture development has had. This policy study will combine time series analysis of agriculture production, trade and deforestation with the evolution of Brazilian environmental policy to illustrate the fragility of policy and the influence competing interests can have on its enforcement and effectiveness. The case study of Brazil will demonstrate that despite having strong environmental protection policies in place, their enforcement and success is dependent on leadership and coordination amongst with key economic sectors and stakeholders.

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INTRODUCTION

Climate change has a myriad of impacts on the planet and those who inhabit it. Food security has become a top global concern in the face of climate change and environmental degradation. Rising temperatures and sea levels, extreme weather events, and growing variability contribute to an increasingly challenging exercise of addressing sustainable development and livelihoods. Expansion in the agriculture sector has meant that many countries have benefited from improved livelihood from agriculture. However, the sector is not only vulnerable to market dynamics but also at risk of being severely impacted by extreme weather events, environmental policies, and their enforcement. If resources and the environment are not effectively managed, it could reduce the long-term benefits from agriculture expansion. Not only is food supply vulnerable to climate change but it also contributes to climate change, through its supply chain and production cycle. Agriculture, along with energy from fossil fuels (electricity, heat and transportation), is one of the most greenhouse gas (GHG) intensive sectors globally.[1] This intersection requires a balance between growing agriculture production and limiting contributions to climate change.

The agriculture sector plays an important role in environmental policy formulation, enforcement and monitoring, especially for major agriculture producers. The Food and Agriculture Organization of the United Nations (FAO) ranks South America as one of the largest agriculture production sub-regions in the world.[2] The Food Security Information Network notes that climate related shocks and changing weather patterns will impact Latin

[1] Ge, Mengpin, and Johannes Friedrich. 2020. 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors. *World Resources Institute*. February 6.
[2] FAO. 2019. FAOSTAT - Compare Data – Production - Crops. *Food and Agriculture Organization of the United Nations.*

America's [3] agriculture production and prices, as well as put pressure on the economy and security.[4] The anticipated effects are particularly relevant to Brazil, as the largest economy in the region and its agriculture sector and related services are a main economic engine.[5] Brazil is also home to globally significant biomes, namely the Amazon and Cerrado[6], whose forests absorb exceptional amounts of carbon dioxide. Unsustainable agriculture production practices, which includes deforestation, could have disastrous consequences on local and global levels. Brazil, aware of the risk and confronted with rapidly rising deforestation, put substantial efforts towards decoupling forest cover loss and agriculture production. Despite great policy success in the 2000s, by 2015 Brazil again faced rising deforestation rates and forest fires in the Amazon and Cerrado regions – often linked to agriculture.

Brazil is at the centre of the climate change conversation because of the country's ecosystem endowment. Since President Bolsonaro took office, this attention has intensified, largely in response to anti-environmental rhetoric, scenes of a burning Amazon and rapidly escalating deforestation. Brazil is an ideal candidate for study on the intersection between environmental and climate policy and agriculture development for four reasons: it contains, within its borders, important global ecosystems and abundant

[3] Latin America is comprised of Mexico, Central America and South America.
[4] FSNI. 2019. 2019 Global Report on Food Crisis. *Food Security Information Network*.
[5] CEPEA. 2018. BR Agribusiness GDP – from 1996 to 2019. *Center for Advanced Studies on Applied Economics.*
[6] The entirety of the Amazon biome covers several countries in South America: Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, Suriname, and French Guiana. Throughout the text of this study, the Legal Amazon consists of the Brazilian state boundaries while the Amazon, unless specified, refers to the Brazilian biome. Specific to Brazil, the Amazon and Legal Amazon will be used interchangeably within the text of this paper due to geographic overlap (three states overlap between Legal Amazon and Cerrado) and based on the literary source's reference. Due to geographical overlap, data specific to the Amazon and Cerrado will be used where possible to delineate the data and avoid overlap. Appendix 1 includes a map of Brazil, outlining which states make up the Amazon, Cerrado and states with overlapping geographies between Legal Amazon and Cerrado.

natural resources; the country has demonstrated experience in climate and environmental policies implemented with varying degrees of success; it is a major agriculture producer and trader; and, it presents unique security and development challenges, particularly in agriculture producing regions. To better understand the intersectionality of climate change, this policy research study will answer the following question: *How has agriculture development influenced climate and environmental protection policy in Brazil?* This policy paper will be organized in four sections: background, hypothesis and methodology, data, and discussion. Each section will elaborate on and assess the intersection between climate and environmental protection policy, and agriculture development.

BACKGROUND

Brazil has been central to discourse around environmental protection and climate policy related to agriculture. However, there has been a growing disconnect between environmental policy and its implementation. To contextualize, this section will provide an overview of climate impacts related to agriculture, Brazil's agriculture sector, and the country's environmental and climate policy, followed by a discussion on international climate agreements and foreign policy. This section will close on with a policy analysis.

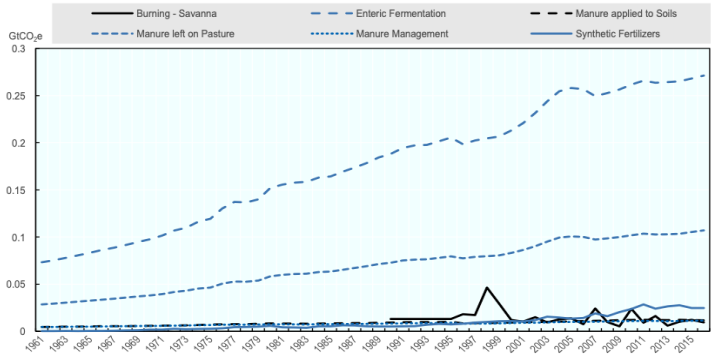
CLIMATE IMPACTS RELATED TO AGRICULTURE

While Brazil and the agriculture sector are facing rising climate risks[7], the agriculture sector has exacerbated climate change in the Amazon. Brazil makes up the biggest share of the Amazon – the world's largest tropical rainforest, a carbon sink providing substantial environmental services not only to Brazil but globally as well. The Amazon "has the capacity to absorb up to 2 billion tons of CO_2 per year, which corresponds

[7] Exploring climate risks to Brazil and the agriculture sector is out of scope of this study.

to about 20 percent of the atmospheric carbon emitted by the burning of fossil fuels."[8] Notably, deforestation of important biomes has the potential to aggravate climate change through lower carbon storage, higher release of carbon dioxide and "changes in rainfall patterns."[9] The Brazilian agriculture sector is often linked to devasting deforestation, which - coupled with emissions - will have calamitous impacts on the biome and its capacity to absorb CO_2. Of recent, research is showing that sections of the Amazon are in fact releasing more carbon than absorbing and reducing carbon storage.[10] Also, "significant increases in agricultural GHG emissions have been recorded in Brazil due mainly to the country's substantial beef herd expansion, which has increased methane emissions from enteric fermentation, and nitrous oxide emissions through increased manure left on pasture"[11] (Figure 1). In a global and domestic context where GHG emissions are at all-time highs and climate change is accelerating, Brazil's agriculture sector is a key candidate for aggressive enforcement of climate and environmental policy.

Figure 1: Source of agriculture emissions in Brazil[12]



[8] Tigre, M. A. 2019. Building a regional adaptation strategy for Amazon countries. *International Environmental Agreements: Politics, Law and Economics*, 19(4–5): p. 412
[9] de Bolle, M., Weisman, S., Moran, T., Wilcox, D., Hendrix, C., Pisani-Ferry, J., Assunção, J. 2019. Policy Brief 19-15: The Amazon Is a Carbon Bomb: How Can Brazil and the World Work Together to Avoid Setting It Off? *Peterson Institute for International Economics*. October: p. 2.
[10] Gatti, Lucinana V., et al. 2021. Amazonia as a carbon source linked to deforestation and climate change. *Nature*, 595: 388–393.
[11] OECD-FAO, 2019, p. 108.
[12] Ibid., p. 107.

BRAZIL'S AGRICULTURE SECTOR

In South America, the agriculture sector has been an important economic and political stabilizer, as well as an important global food supplier. Brazil is the top agriculture and food trader in Latin America.[13] Spanning from forestry to livestock, Brazil's main agriculture products include soybean, sugar cane, ethanol, wheat and processed meat.[14] Historical production and trade trends in the Amazon and Cerrado show significant increases in production of soybean and cattle raising.[15] Moreover, the Legal Amazon and Cerrado (representing over 70% of Brazil's land area) are the two regions that have experienced the highest growth in agriculture. The Brazilian agriculture sector and its related services make up just over 21% of the country's economy[16] and contributes to approximately 20% of formal employment.[17] The sector's centrality to the economy has led to heavy policy support through government programs such as PRONAF (National Programme to Strengthen Family Farming – small farmers), PAP (Crop and Livestock Plan – medium and large farmers) and PRONAMP (National Programme to Support Medium Rural Agricultural Producers).[18] The first two program were combined in 2020-2021 to form Plano Safra as the primary agriculture credit program with funding announced annually.[19] This assistance includes credit provisions and development programing such as a system of earmarking financial operations (rural credits) and subsidized funds directed at

[13] Ibid., p. 108.
[14] Ibid., pp. 76, 88.
[15] Ibid., p. 108.
[16] CEPEA, 2018.
[17] World Bank. 2018. Policy Note: Brazil - Improving the Efficiency of Credit Markets. *World Bank - FCI GP*. August: p. 12
[18] Ibid; Souza, Priscila, Stela Herschmann, Juliano Assunção. 2020. *Rural Credit Policy in Brazil: Agriculture, Environmental Protection, and Economic Development*. Climate Policy Initiative. December: p. 18.
[19] Souza et al., 2020, pp. 18-19.

priority sectors, mainly real estate and rural activities.[20] Importantly, while policy support has stimulated rapid socioeconomic improvements, Brazil's complex reality has limited the effectiveness of these programs.

For communities surrounding the Amazon and Cerrado, in the North and North-East of Brazil, agriculture production has contributed to lowering poverty rates and improving livelihoods. In line with strong growth, the agriculture sector has contributed tremendously to the reduction in rural poverty among agriculture producing families, who experienced a halving of extreme poverty rates in a span of ten years.[21] On a national level, however, Brazil is facing an upward trend in poverty rates and stagnating improvements in inequality. Also, the toll climate change has taken on human health in the Amazon and Cerrado regions directly affects the population's ability to attend school and work, thereby putting livelihoods at risk: "Amazon firestorms have increased incidence of respiratory diseases, crop and infrastructure losses, and forest degradation, when deforestation and management fires ignite wildfires."[22] Of note, "Brazil's public health system (SUS) alone had to spend US$ 11 million in health treatment related to respiratory diseases in the Amazon region."[23]

The agriculture industry can be linked not only to health problems but also to corruption. Brazil consistently ranks above the median of the World Bank's Control of Corruption Index[24]. While corruption is endemic throughout the country, the Amazon's

[20] Ibid.
[21] Soares, Sergei, Suarez Dillon, Laeticia Rodrigues de Souza, Wesley Vieira da Silva, Fernando Gaiger da Silveira, Áquila Campos. 2016. Poverty profile: The rural North and Northeast of Brazil. *International Policy Centre for Inclusive Growth (IPC-IG)*, Working Paper, No. 138: p. 3.
[22] Silvério, Divino, Silva, S., Alencar, A., & Moutinho, P. 2019. Amazon on Fire. *Amazon Environmental Research Institute (IPAM)*: p.1.
[23] Ibid., p. 2
[24] World Bank. 2020. World Governance Indicators. *World Bank*.

remoteness as well as heavy presence of criminal organizations and drug trade has further contributed to the problem. A high level of local corruption in the Legal Amazon can be traced back to pressure from large agriculture producers who challenge land protection and enforcement. Mato Grosso, for example, was hit by several scandals linking large agriculture producers to local officials in 2008.[25] Under similar circumstances, Environment Minister Ricardo Salles resigned in June 2021 while facing criminal investigations over his role in the illegal logging trade in the Amazon and slowing down environmental investigations.[26] Strong institutions can shield against corruption and help in weeding out structural weaknesses; however, Brazil has consistently ranked poorly in global institutional and governance indices including those related to government effectiveness and public-sector performance.[27] As such, irrespective of policies, the ability to effectively implement is crucial.

ENVIRONMENTAL PROTECTION POLICY[28]

Brazil's early environmental policies were mainly developed to limit deforestation, protect forests from depletion through the creation of protected areas and zoning. Mounting discourse on the intersection between environmental protection and sustainable development also influenced early policies in the 1970's through industrial zoning and later boosted by "the debate on the relation between the environment and sustainable

[25] Le Tourneau, François-Michel. 2015. Is Brazil now in control of deforestation in the Amazon? (Translated from Le Brésil maîtrise-t-il (enfin) la déforestation en Amazonie?). *European Journal of Geography*.
[26] Brito, Ricardo. 2021. Brazil's Supreme Court Authorizes Criminal Probe into Environment Minister. *Reuters*. June 21.
[27] World Bank. 2020; Schwab, Klaus. 2019. The Global Competitiveness Report 2019. *World Economic Forum*: pp. 110-111.
[28] Further details included in Appendix 2 and 3.

development …[in] the 1990's."[29] Federal, state and municipal institutions mostly worked to reduce pollution and protect and zone land through the establishment of national policies, supporting economic growth while considering finite natural resources.[30]

During a major wave of neo-liberal economics, Brazil's environmental agenda expanded; it gained public support, advanced climate change performance, and elevated Brazil's status as a global environmental steward. Brazil's global climate narrative took hold in the 1990's and intensified by the late 2000's as Brazil was able to curtail rapidly rising deforestation rates.[31] Brazil's effort to curb deforestation and related policies rested on a critical piece of environmental policy - the Forest Code – leveraging a highly successful command-and-control approach. Many institutional and regulatory systems were put in place, including black-list mechanisms, the Action Plan for Prevention and Control of Brazilian Amazon Deforestation (PPCDAm)[32] and the National Policy on Climate Change (NPCC). Within the NPCC sit certain sectoral mitigation plans including Plano ABC (Plano Agricultura de Baixa Emissão de Carbono (Low-Carbon Agriculture)) who's "objective is to promote the reduction of GHG emissions in agriculture and enable the agricultural sector to adapt to climate change."[33] On paper, the Legal Amazon is governed by relatively robust environmental policies and laws. However, competing

[29] Neves, E. M. S. C. 2016. Institutions and Environmental Governance in Brazil: the Local Governments' Perspective. *Revista de Economia Contemporânea*, *20*(3): p. 495.
[30] Ibid., p. 498
[31] Eduardo, V., and Franchini, M. (2017). Brazil and climate change : Beyond the amazon. ProQuest Ebook Central: p. 38.
[32] Since 2004, the PPCDAm was able to reduce deforestation rates significantly. See Appendix 3 for more details.
[33] Souza et al., 2020, p. 48.

economic and political interests led to a break with the environmental agenda in the 2010s, kickstarted by a change in leadership and, later, an economic crisis.[34]

A major turning point was the Forest Code's reform in 2012. While de Bolle argues that the 2012 Forest Code can be viewed as "one of the strictest environmental laws in the world," it nevertheless represented a step back from the 1965 Forest Code. The 2012 reform ultimately undermined federal power on "environmental control" and relaxed "restrictions related to the status of protected areas."[35] Recently, President Bolsonaro's administration (2018-2022) has marked a further shift away from environmental protection by appointing "ruralists" linked to the agriculture lobby in key positions and shifted responsibility of forest fire monitoring mandates to the Ministry of Agriculture, as examples.[36]

Continuous years of weak economic growth has also led to a reduction in resources funnelled to administrative and monitoring institutions for the environment.[37] Highly dependent on federal transfers, they now face budgetary and staff cutbacks. To illustrate, between 2010 and 2014, allocations to the Environment Ministry totalled 0.4% of federal spending – a relatively high amount following a 48% increase during this period.[38] These allocations were drastically cut in the following years, and they are on a devasting trend. In 2021, the Bolsonaro administration cut the Environment Ministry's budget to 2.1 billion reais (0.1% of total public spending), representing a 30% reduction from the previous

[34] Eduardo, V., and Franchini, M. 2014. Brazilian climate politics 2005-2012: Ambivalence and paradox. *Wiley Interdisciplinary Reviews: Climate Change*, *5*(5): p. 679
[35] Neves, 2016, p. 495.
[36] Watts, Jonathan. 2021. Amazon rainforest 'will collapse if Bolsonaro remains president'. *Reuters.* July 14.
[37] de Bolle, 2019.
[38] OECD. 2015. OECD Environmental Performance Reviews: Brazil 2015. *Organisation for Economic Co-operation and Development (OECD),* p. 6.

year's budget. This cut occurred even though the administration publicly committed to finance the enforcement of environmental protection, including ending illegal deforestation.[39] Still, institutional capacity at all levels of government will continue to deteriorate, especially if this funding gap is not plugged.

Brazil, as a federalist system, delegates most law enforcement and monitoring to state and municipal governments and institutions. The benefits of such delegation are greater local control over conditions, allowing localities to develop laws and policies tailored to their own needs. However, in an already insecure region, when livelihoods are put at risk, instability can increase and diminish the effectiveness of environmental policy. Limited budgets and capacity, and lack of infrastructure, have greatly reduced the ability of local governments to be present in remote areas and address illegal activity, resulting in escalating violence and the ensuing environmental impacts. Criminal activity and drug trade in the Legal Amazon has also contributed to high levels of violence. Activists and civil society are scarcely protected in this context, which limits their effectiveness in remote areas. While illegal activity and lack of enforcement have been a persistent challenge in the Legal Amazon, the current context is expected to exacerbate the problem.[40]

Influenced by weak economic growth limiting the financial capacity of institutions, environmental regulations have been relaxed in favour of economically developing the Amazon and Cerrado (e.g., mining, forestry and agriculture). This shift has altered Brazil's trajectory towards reducing climate impacts and vulnerabilities. Brazil was successful in cutting deforestation rates drastically in the 2000's through stronger environmental policies and leadership; however, policies have proven to be vulnerable to the impulse of the

[39] BBC. 2021. Brazil cuts environment budget despite climate summit pledge. *BBC*. April 24.
[40] de Bolle, 2019.

political establishment and insufficient in the face of competing interests. Of note, "an extreme focus on short-term considerations and the predominance of fragmented interests—…central obstacles for the full development of Brazil as a reformist power in international climate governance…Brazil has been unable to complement its huge physical–environmental capital with an advanced political–social–environmental capital."[41] Domestically, environmental and climate policy are facing an uphill battle under Bolsonaro, but international pressure is mounting too.

INTERNATIONAL CLIMATE AGREEMENTS AND FOREIGN POLICY

Central to global climate dialogue is the Paris Agreement, which was signed on 4 November 2016 and came into force in 2020. The Agreement "aims to keep the global average temperature rise to 'well below' 2°C above pre-industrial levels… [and] limit the temperature increase to 1.5°C."[42] According to the Agreement, the target is firstly achieved by reaching peak global GHG emissions as soon as possible, with the goal of achieving net-zero emissions by 2050.[43] Secondly, signatory countries attest to voluntary climate action commitments under the (Intended) Nationally Determined Contribution (INDC/NDC) to the United Nations Framework Convention on Climate Change (UNFCCC). Brazil has an NDC in place, which incorporates Reducing Emissions from Deforestation and Forest Degradation (REDD+).[44] Brazilian climate targets have incorporated international commitments and are also included in its NPCC. Running in parallel, Brazil's NDC aims to reduce emissions by 37% and 43% below 2005 levels, by

[41] Ibid., p. 686.
[42] Gallo, P., and Albrecht, E. 2019. Brazil and the Paris Agreement: REDD+ as an instrument of Brazil's Nationally Determined Contribution compliance. *International Environmental Agreements: Politics, Law and Economics*, *19*(1): p. 124.
[43] Ibid.
[44] Ibid. Further discussion on REDD+ in Appendix 3.

2025 and 2030 respectively. As it stands, Brazil's NDC is insufficient and inconsistent with the Paris Agreement's objective of limiting global warming to 2°C.[45] As such, upping its targets and efforts is required to contribute a fair share to climate action. Unfortunately, Brazil's current leadership is unlikely to commit to aggressive action.

Running counter to the Paris Agreement is the Bolsonaro administration's approach and rhetoric around climate change and environmental protection. Historically, Brazil had a strong track record of environmental activism and a relatively engaged civil society, particularly amongst lower income Brazilians. By the mid-1990's, when compared to Western European countries, Brazilians were similarly engaged in environmental complaints and issues at the local and global level; Brazil also ranked high in group and grassroots environmental activism.[46] Many believe that the recent uptick in deforestation can partially be attributed to the government's tone on environmental protection and climate change. More concretely, President Bolsonaro's call for the relaxation of environmental regulations in favour of developing the Legal Amazon has created a setting of leniency. But given the global context, the Brazilian government is in for a tough diplomatic fight. The Amazon Fund – mostly funded by Norway – has invested in projects to improve monitoring and reducing deforestation in the Amazon since its establishment in 2008.[47] However, Bolsonaro's attempts to change the Amazon Fund rules and structure led to the halt in funding by Norway and Germany, putting environmental protection efforts at risk.[48]

[45] Climate Action Tracker. 2020. Brazil. *Climate Action Tracker.*
[46] Jacobs, J. (2002). Community Participation, the Environment, and Democracy: Brazil in Comparative Perspective. Latin American Politics and Society, 44(4): p.
[47] de Bolle, 2019
[48] Ibid.

As global climate discourse evolves, trade and investment into Brazil is facing greater scrutiny. Increasingly, trade negotiations are incorporating climate change and ESG considerations. An uncooperative nation may be left out of economically beneficial arrangements. For example, mounting opposition to Brazil's approach on environmental issues has weakened the nation's position in the Mercosur-EU trade agreement negotiations. In 2020, the EU halted trade negotiations with Brazil because it opposed Bolsonaro's lack of action in response to deforestation and rapidly spreading wildfires in the Amazon[49]. International cooperation and pressure are proving to be effective mechanisms for climate action. Yet, international demand, particularly from China, continues to play a significant role in the expansion of Brazil's agriculture sector. International pressure to improve environmental protection and expand climate action is gaining traction; however, Brazil's expanding agriculture trade is countering this trend.

POLICY ANALYSIS

Historically, Brazil developed strong environmental policies that were successful in significantly addressing deforestation while developing its agriculture sector through robust development programs. The Forest Code provides a solid foundation for environmental protection policy with various action plans and programs under it. However, in the face of economic turmoil and absence of environmental leadership, environmental policies are only as strong as their implementation. Starting in the mid-2010's, economic and political interests have gained momentum at the expense of environmental protection. This disconnect demonstrates that Brazil has largely developed environmental policy in a silo, making it vulnerable to weakening or being overshadowed. As noted by Gallo and

[49] Koop, Fermin. 2020. *EU parks trade deal with Mercosur over environmental concerns. Buenos Aires Times.* October 17.

Albrecht, Brazil's "institutional design…does not respond to the need of implementing complex environmental policies, once the environmental arena affects territorial management and requires contributing actions from all levels of government, making its implementation more difficult."[50] Moreover, the practical effectiveness of Forest Code programs need to evolve. As an example, the PPCDAm and PPCCerrado have done an extremely good job at developing data and systems for monitoring bringing visibility and quantifies the deforestation problem. However, there doesn't appear to be thresholds for practical action.

The fragility of institutions and their enforcement capacity, as well as limited interconnectedness is restricting the country's climate action. Research shows that what is missing in Brazil's approach is "policy coherence (referring to policy outputs and outcomes) and policy integration (referring to governance arrangements and policymaking processes) [to] create a positive interplay enabling the establishment of cross-sector mechanisms among governance levels."[51] Also, it is crucial to connect "environmental and production policies with social and equity concerns."[52] In agriculture, Brazil has struggled to structurally engrain environmental protection policies into sustainable agriculture development policy. For example, Plano ABC is only a small fraction of Plano Safra when it could integrate its sustainability and conservation measures into all agriculture credits provided by financial institutions. Moreover, funding options are complex and difficult to navigate making them harder to access for smaller farmers.

[50] Gallo and Albrecht, 2019, p. 131.
[51] Gallo and Albrecht, 2019, p. 132.
[52] Milhorance, C., and Bursztyn, M. 2019. Climate adaptation and policy conflicts in the Brazilian Amazon: prospects for a Nexus + approach. *Climatic Change*, *155*(2): p. 228.

Up until now, Brazil has developed and implemented anti-deforestation policies, making up much of the country's climate policy, but a siloed approach to environmental policy and agriculture development has thwarted those efforts. As agriculture opportunities expand, it is critical to strengthen institutions to ensure effective implementation of policy. The more environmental policy is viewed holistically and integrated into the suite of economic policies, the less susceptible it is to political whim and influence from competing interests. For the agriculture sector, engraining environmental policy into equitable development programs and strategies requires incentives and partnerships supported by strong leadership.

HYPOTHESIS AND METHODOLOGY

The main hypothesis to be tested is that weak institutionalization and enforcement of environmental protection policy in Brazil has allowed for increasing deforestation as agricultural development has increased. This paper will aim to address this hierarchy of needs by assessing Brazil's institutions, policies, and trends in agriculture development and by demonstrating that actions taken by the Brazilian government counter the image of progressive environmental policy developed in the 1990's to mid-2010's. This policy research study will leverage multi-methods, incorporating a case study of Brazil along with quantitative analysis. The case study will be a historical assessment of two focus areas and their evolution through time: environmental and climate policy and agriculture production and trade. While not the focus of this paper, issues related to socioeconomic security in agriculture producing areas will be explored given the implications on competing interests and enforcement capacity.

The case study will incorporate time series analysis of agriculture production and trade, emissions and deforestation rates nationally and by state (when available) to support the historical accounts of climate and environment, economic development, finance policy in Brazil. Most data are pulled from official sources including Brazilian federal agencies and state governments; multilateral agencies (e.g., United Nations and World Bank); and organizations and academics with expertise (e.g., Peterson Institute, IPAM). To test if the hypothesis is correct, data will be used to show a demonstrable deterioration in environmental policy enforcement and rising deforestation rates related to agriculture development. Reduction in deforestation was possible during a period of rising agriculture production and trade; however, it is when leadership and policy shifted, and more importantly enforcement, that we start to see degradation in environmental protection and climate policy.

DATA

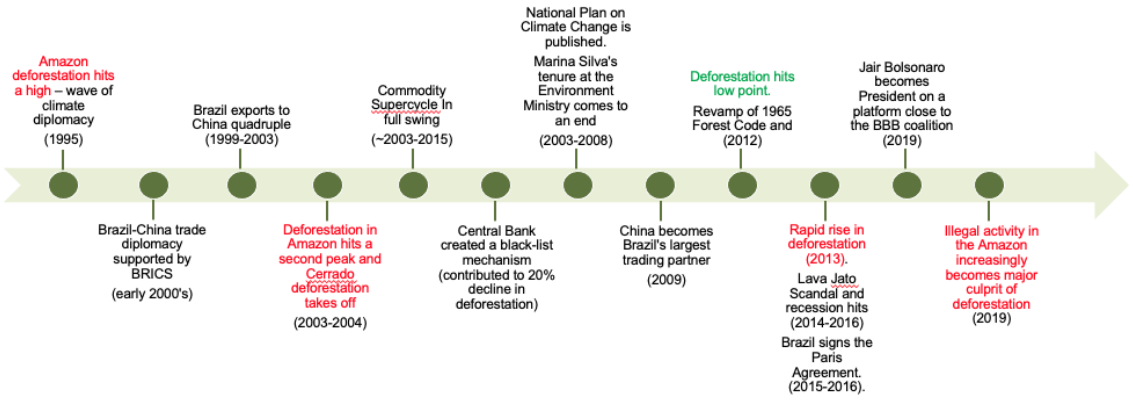
This section will address institutional and policy gaps in environmental and climate policy. Next, it will present trends in agriculture and trade indicators in conjunction with climate related data, including emissions and deforestation; it will also discuss trends in sustainable development, including finance programs. To set the stage, a timeline will outline key events.

TIMELINE

Historically, Brazil has been a global environmental steward; but today, it is facing rising deforestation, putting into question its approach to environmental and climate policy. Brazil pioneered deforestation policy through various environmental protection legislation, mostly through a command-and-control approach and the Forest Code of 1965. However,

Brazil did not concurrently institutionalize these policies throughout government and economic sectors, thereby weakening the ability to implement and enforce. Over time, competing interests, strong demand and incentives to rapidly expand agriculture trade undermined the government's ability to manage deforestation (Figure 2).

Figure 2: Timeline of Key Events



INSTITUTIONS AND ENVIRONMENTAL POLICIES[53]

Brazil has a relatively advanced foundation for environmental protection contributing to climate policy, starting with the constitution. As mentioned, Brazil boasts an internationally recognized Forest Code, which is the basis of its national policy. By the time a new Brazilian constitution was in place in 1988, a national framework had already been established to manage the environment through mandates and principles. For instance, the constitution declared the "inclusion of the environment as a diffuse and collective interest under the responsibility of public prosecutors[54] [who assumed] responsibility for environmental regulation enforcement, particularly through civil lawsuits against offenders…; and the establishment of the principle of strict liability."[55] This constitutional

[53] While environmental and climate policy is more expansive, this section will focus on governance related to deforestation and areas such as water, energy and pollution management are out of scope for this paper.
[54] Ministério Público or Federal Public Ministry
[55] Neves, 2016, p. 499

inclusion was further strengthened through the understanding of a "shared [and comparable] responsibility among the federal, state and municipal levels" and coupling environmental issues with economic and social development.[56] By the early 1990s, Brazil had gradually improved its institutional and governance framework, buoyed by the global environmental agenda. The agenda was centered around accountability for "environmental degradation [which] was correlated to unsustainable patterns of production and consumption, poverty, urbanization, and international trade."[57] In Brazil, several regulations and legislations were established such as the Environmental Crimes Law of 1998 and rules related to environmentally protected areas and education.[58] By the turn of the 21st century, Brazil was a recognised environmental guardian domestically and internationally.

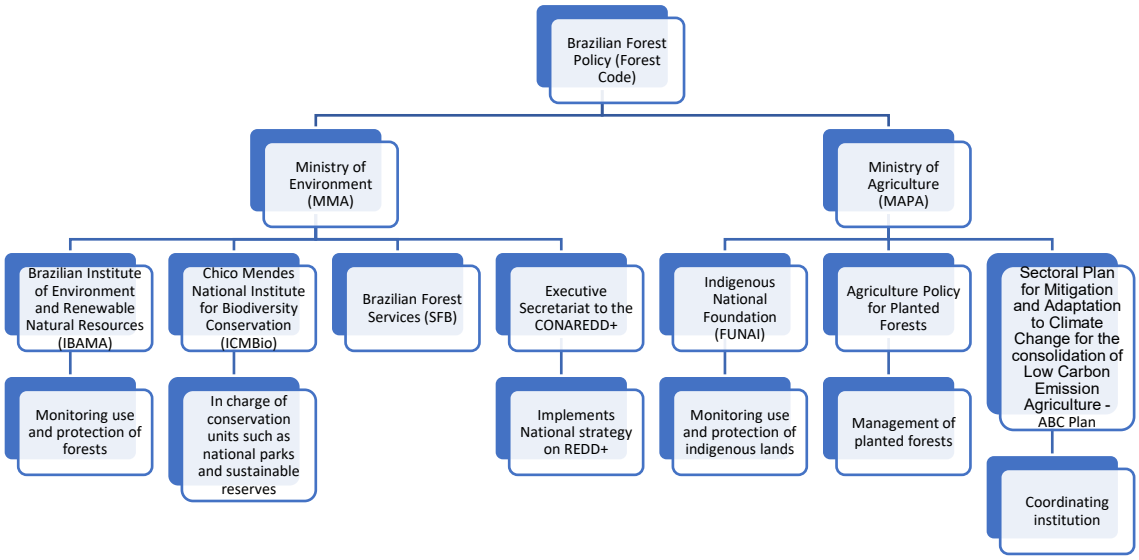
INSTITUTIONAL STRUCTURE AND LEADERSHIP

As a federal state, Brazil's governance structure incorporates three levels of government: federal, state, and municipal. The federal government leads on international commitments and national policy, and state and municipal institutions translate them to the local context. Much of Brazil's institutional governance is linked to the 2009 NPCC and its Forest Code, featuring several ministries[59] (Figure 3). Through the development of environmental institutions, regulations and frameworks, the focus increasingly became curbing deforestation under the highly successful leadership of a Ministry of Environment

[56] Ibid., pp. 499-500
[57] Ibid., p. 501
[58] Ibid.
[59] Most relevant to this paper: Ministry of Foreign Affairs (MRE), Ministry of Science, Technology, Innovation and Communication (MCTIC), Ministry of Environment (MMA) and Ministry of Agriculture (MAPA). Further details included in Appendix 2.

(MMA) led by Minister Marina Silva[60] (2003-2008). Supported by former President Lula da Silva, Silva's MMA forged an instrumental alliance between Lula's party, the PT, and environmental groups boosting public awareness of deforestation and promoting

Figure 3 - Brazilian Institutions Responsible for Forest Policy[61]



collaboration amongst stakeholders.[62] The ministry benefitted significantly from its growing influence domestically, thanks to its success in reducing deforestation while supporting development in ethanol and hydropower, for example. Furthermore, international climate policy boosted its profile.[63] During this period, deforestation targets in forest policy, namely the Forest Code, contributed to GHG emission reduction. A command-and-control approach to forest management, monitoring and protection became a core mechanism for climate policy. By 2007, deforestation rates and agriculture prices (which stimulated production) decoupled, demonstrating that sustainable development

[60] Silva resigned in 2008 due to tensions with competing interests and growing rift between Silva and Lula. Silva was replaced in Carlos Minc. Phillips, Tom (2009). Brazil's former environment minister leaves ruling party over 'destruction of natural resources'. The Guardian. August 19 2009.
[61] Gallo and Albrecht, 2019, p. 126
[62] Eduardo and Franchini, 2014, p. 681.
[63] Ibid.

without rising deforestation was possible, but not without strong leadership and collaboration.

Federal politics is also heavily influenced by the Brazilian Congress. Brazil functions under a coalition system of government with representation from over 30 parties. Therefore, it is highly unlikely that a single party can hold a majority, making coalitions necessary for policymaking. Since Brazil's return to democracy in 1985, dependence on coalitions has contributed to a highly fragmented system, influenced by vested interests (namely agriculture, energy, and industry) and dominated by pork barrel politics related to the BBB coalition (Beef for agriculture, Bible for evangelical Christians, and Bullets for gun-rights). As mentioned, short-term considerations and economic interests can thwart decision-making and impact the government's approach to environmental concerns.

FOREST CODE AND ENVIRONMENTAL POLICY[64]

The Forest Code sets parameters for deforestation and reforestation. Specifically, it obliges landowners to maintain a minimum portion of permanent forest cover: 80% in the Amazon and 20% on other lands.[65] Also, "the Brazilian NDC pledges to compensate for 'legal suppression of vegetation'."[66] The Forest Code has also provided a framework for farmers to receive technical and financial support from private sector, civil society and international organizations such as the Amazon Fund, German bank KfW and Mato Grosso Agribusiness Federation (FAMATO) in navigating various mechanisms including the

[64] Further details provided in Appendix 3.
[65] Milhorance, C., and Bursztyn, M, 2019. p. 224.
[66] Gallo and Albrecht, 2019, p. 135.

Environmental Reserve Quota (CRA).[67] A market for forest compensation and offsets is developing but it is disjointed and the laws regulating compensation are outdated.[68]

As part of its NPCC, Brazil has set various objectives that aim to improve forest management to reduce deforestation and climate change impact. Of note, the PPCDAm outlines eight specific objectives, such as integrating "fire management with a view to reduce forest fires that are harmful to biodiversity" through developing various programmes and plans as well as increasing personnel capacity.[69] Other objectives touch on improving real-time data management and collection, promoting forest concessions, and expanding access to credit for sustainable forest management measures.[70]

ENVIRONMENTAL POLICY IMPLEMENTATION

Having ministerial institutions and mandates in place is only part of the equation. Brazilian institutions are often characterized by their heavy bureaucracy and complexity, making coordination across government challenging. Policy needs to be translated into direct action and measures. Unfortunately, environmental protection and climate policy implementation face several barriers, most of which grew evident in the early to mid-2010s when more robust domestic plans and international agreements were enacted (e.g., REDD+ and Paris Agreement). Gallo and Albrecht summarize the key obstacles: "(1) problems in design and planning, (2) transparency, (3) difficulties of coordination between institutions, (4) lack of budgetary resources and qualified personnel, (5) failure in the use of credit lines created for sustainable production and (6) low capacity of technology transfer."[71]

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[67] Milhorance and Bursztyn, 2019, pp. 223-224.
[68] Lopes, Cristina Leme, Julia Nardi and Joana Chiavari. 2021. Regulating Forest Compensation for Legal Deforestation in Brazil. *Climate Action Initiative*. August 3.
[69] UNFCCC. 2019. Brazil's Third Biennial Update Report to the United Nations Framework Convention on Climate Change. *United Nations Framework Convention on Climate Change (UNFCCC).* p. 25
[70] UNFCCC, 2019, p. 7-9.
[71] Ibid., p. 130.

The MMA has been confronted with Brazil's fragmented political environment limiting its effectiveness. Moreover, single person dependence was (and is) relatively high in Brazil; once Silva left office, the public lost its symbol of environmental guardianship and the environmental movement suffered.[72] By the time Izabella Texeira took over the helm at MMA in 2011 and Silva was decisively out of federal politics, the MMA's political influence had dwindled. Under President Dilma Rousseff (2011-2016), the MMA shifted to a more economically conservative position, supported the Forest Code's reform in opposition to environmentalists and broke the alliance between environmentalists and the PT party in 2012.[73] The rift widened as the country entered one of its most challenging economic periods, leading to the impeachment of Rousseff and the Lava Jato scandal.[74] Without an environmental leader such as Silva, priorities shifted, and the environmental and climate agenda fell out of favour, replaced by economic concerns. As the leading and coordinating body, the MMA should have addressed these barriers; however, it has not proved effective.[75]

Today, these challenges continue and governmental ineffectiveness stalls progress on major policy needs, including climate. Under the current administration, Bolsonaro named Tereza Cristina Diaz as Brazil's agriculture minister; Diaz is a known pro-agribusiness "ruralist", closely aligned with the Beef coalition, and she has signaled intentions to expand commercial farming on protected indigenous lands.[76] Brazil has built

[72] Eduardo and Franchini, 2014, p. 685.
[73] Ibid., p. 683-685.
[74] Corruption investigations centered on the payment of bribes through overpayment of infrastructure projects and contracts through Petrobras, Brazil's government owned oil and gas company.
[75] Gallo and Albrecht, 2019, pp. 128-129.
[76] Webb, Hannah and Raquel Nunes Palmeira. 2018. Bolsonaro: Trump of the tropics. *Socialist Lawyer*, No. 80 (October), p. 21; Spring, Jake, and Anthony Boadle. 2019. Brazil agriculture minister wants to open indigenous land to commercial farming. *Reuters.* January 19.

up an international reputation for institutionally developing delegations of authority to support environmental protection and climate policy; however, competing interests fight against these authorities.

COMPETING PRIORITIES

Compounding the barriers of heavy bureaucracy are limited collaboration and dialogue amongst key stakeholders, conflicting priorities, and corruption. The absence "of dialogue with civil society, federal states and mainly indigenous and traditional communities" adds to the lack of "coordination and compatibility among the NPCC, environmental policies and development goals."[77] Further, "the difficulties to get the projects financed, promoting a mismatch between the resources available and the disbursement to support projects," results in "marginalising indigenous, small landowners and forest communities, and neglecting their chance to get projects supported."[78] Competing priorities between international commitments and federal and state direction are also limiting support for projects.[79]

While Brazil had maintained a positive image in terms of the international climate change agenda prior to Bolsonaro, policymaking and enforcement has veered in the other direction.[80] Specifically, agribusiness, transportation and energy sectors have played the biggest roles in lobbying the legislature and executive to relax regulations to develop projects. Gallo and Albrecht posit that numerous legislative and constitutional proposals have been brought forward to the National Congress aiming to relax "regulations on large-scale projects such as mining, hydropower dams and road building, and expansion of

[77] Gallo and Albrecht, 2019, p. 132.
[78] Ibid., p. 130.
[79] Ibid.
[80] Eduardo and Gonçalves, 2019, p. 3.

agriculture activities." Constitutional Amendment (PEC) 65, for example, "facilitate[d] licensing for large-scale infrastructure projects without evaluation and mitigation of environmental impacts"; and as a result, it will severely threaten forests and "cause…extensive environmental damage."[81]

The NDC outlines specific targets aligned with these competing interest sectors; however, there appears to be limited coordination between the development of these opportunities. The view of the agribusiness sector is that the climate change narrative is "a threat to the expansion of the sector, which relies heavily on the use of freshwater, soil, chemicals, and fertilizers…[and] has also been a beneficiary of illegal deforestation."[82] As such, rural and informal financial credits are provided to promote agriculture activity without the requirement to address climate impacts. For example, the ethanol sector has been key to stimulating agriculture activity and investment. Brazil is a global leader in flex-fuel technology that allows automobiles to switch between ethanol and fossil fuel. In 2006 President Lula introduced the "so-called 'Ethanol Diplomacy'…aiming to constitute a global economy for Brazilian biofuels," and by 2007 Brazil announced a partnership with the United States to develop the market.[83] While deforestation rates had declined, ethanol diplomacy came at a time when the political anti-deforestation movement was losing ground.

Finally, trade has also fueled the conflict between agriculture production and climate diplomacy, as evident in the relationship between Brazil and China. Due to its sheer size, China is one of the world's most important food importers, and Brazil has become a

[81] Gallo and Albrecht, 2019, p. 136.
[82] Eduardo and Franchini, 2014, p. 679.
[83] Ibid., p. 682.

key supplier. The Brazil-China Bilateral Trade Agreement was signed in 1978 at a time when China was reintegrating into the global economy, aided by Brazil's support for its World Trade Organization membership. Under the administrations of Fernando Henrique Cardoso (1995–2003) and Lula (2003–2011), Brazil developed into a global trader and China became one of its main customers.[84] By 2009 China was Brazil's main trading partner, and by 2019 it accounted for 29% of total exports, with soybeans and processed meat making up the largest share.[85] From 2009 to 2019, Brazilian shipments to China grew by 12% CAGR, with soybeans and processed meat products making up almost 40% of exports by 2019.[86] To meet this rising demand from China, Brazil's soybean and meat production expanded, encouraging substantial investment in Brazil.

Through China's One Belt, One Road Initiative, the Brazil-China Fund (launched in 2017) established "a mechanism to finance projects of common interest in infrastructure, logistics, energy, mining, and agribusiness, among others."[87] The agriculture sector's promotion through trade and investment has likely influenced rising deforestation rates in the past 10 years, limiting climate adaptation capacity. Broader foreign policy could be further stimulating Brazil's agricultural growth. China has expanded its climate action and integrated some climate policy into its long-term economic planning; however, it has predominantly focused on energy and technology innovation rather than a holistic climate action plan.[88] As China increasingly replaced the US and became Brazil's top trading partner, economic considerations overshadowed climate discourse. China and Brazil

[84] Vieira, V. R. 2014. Is politics behind trade? The impact of international trends and diplomatic action on Brazil's exports during globalisation. *Bulletin of Latin American Research*, *33*(2): p. 140.
[85] UN, 2019.
[86] UN, 2019.
[87] Péra et al., 2019, p. 400.
[88] Leiteritz, Ralf J. 2013. Changing Weather: China's Role in Latin America's Climate Change Policy. *Papel Político*, Vol. 18 (No. 1), January-June: p. 338.

reinforced the view that development would be at risk if aggressive climate action was taken, in line with the Brazilian agriculture lobby but in opposition to the US view.[89] Overall, domestic and international environmental and climate policy have taken a turn in Brazil.

AGRICULTURE AND CLIMATE DATA[90]

While agriculture production occurs throughout the country, concentrations of production and establishments differ by area. The North-East makes up over 45% of farming establishments in Brazil. Over half are small establishments (<0.1 ha), with establishments in Mato Grosso and Minas Gerais holding the largest agriculture areas in the country.[91] In terms of larger establishments (>1,000 ha), Mato Grosso, Mato Grosso do Sul and Pará make up over 45% of the total. Despite Mato Grosso accounting for only 2% of farms, they hold over 15% of the country's agriculture production area. Much of the growth in establishments is attributed to two Amazon States: Pará and Mato Grosso.[92] Overall, in terms of farm establishments, the most important states in the Amazon and Cerrado are Bahia, Minas Gerais, Mato Grosso, Mato Grosso do Sul and Pará.

Within the Amazon and Cerrado, eight states (Figure 4) make up 60% of total cropland.[93] The agriculture sector is diverse but nonetheless dominated by soybean and

[89] Ibid., p. 340.
[90] Given their importance, soybean and beef will be used as proxies for agriculture development. Moreover, Brazil's deforestation data follows a reference calendar of August to July; however, for the purposes of this study and comparability, data will be set to a calendar year except for in-text notations on deforestation trends.
[91] IBGE. 2017. Census of Agriculture. Tabela 6754 - Número de estabelecimentos agropecuários e Área dos estabelecimentos agropecuários, por tipologia, condição legal das terras, grupos de atividade econômica e grupos de área total. *Brazilian Institute of Geography and Statistics.*
[92] Ibid.
[93] Original data heading is "agriculture area" defined by IBGE as land used to produce food, fibres, and other raw materials. While generally agriculture area includes livestock rearing, IBGE disaggregates livestock from agriculture area; therefore, data will be labelled as cropland rather than agriculture area. IBGE (2018). Monitoramento da Cobertura e Uso da Terra do Brasil. Brazilian Institute of Geography and Statistics.

beef. Of Brazil's 27 states, 16 count soybeans as 1/3 of all planted area, eight of which count soybean as more than half.[94] At the state level, Mato Grosso's planted area is over 20% of Brazil's total, with soybean reaching almost 60% and growing 5% CAGR since 2010.[95] Mato Grosso is the largest soybean producer in Brazil, followed by Paraná[96] (Figure 5).

Figure 4: Use of Land - Cropland[97]

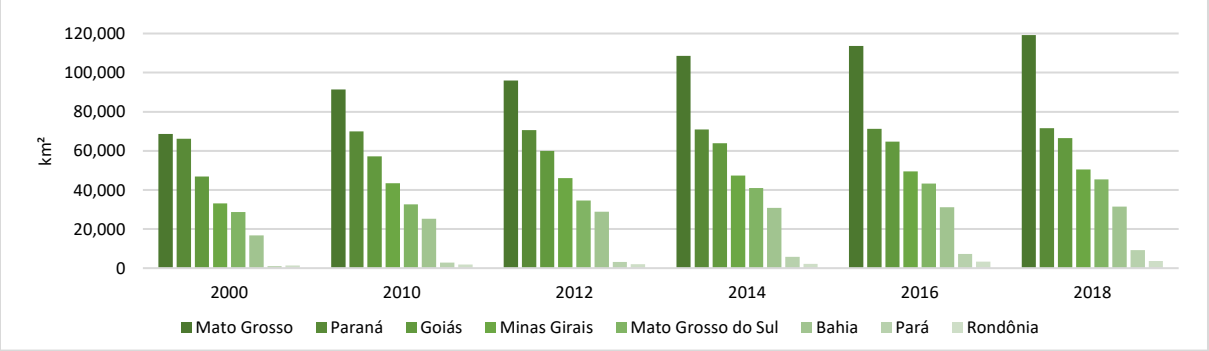
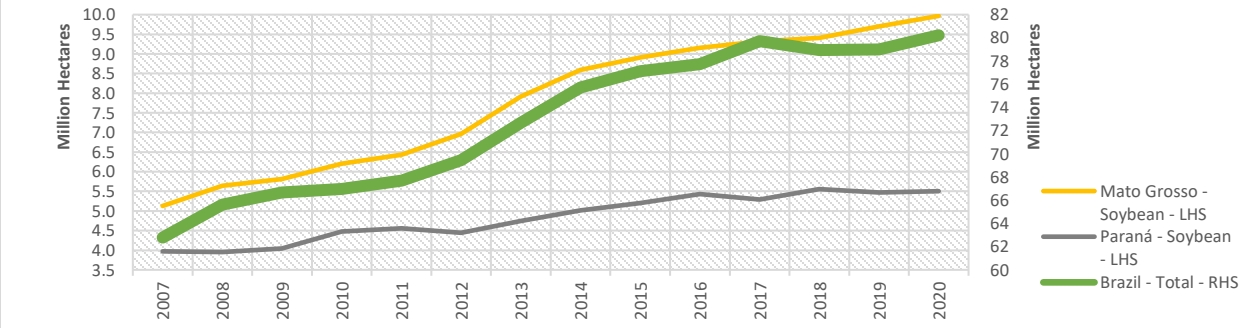


Figure 5: Planted Area[98]

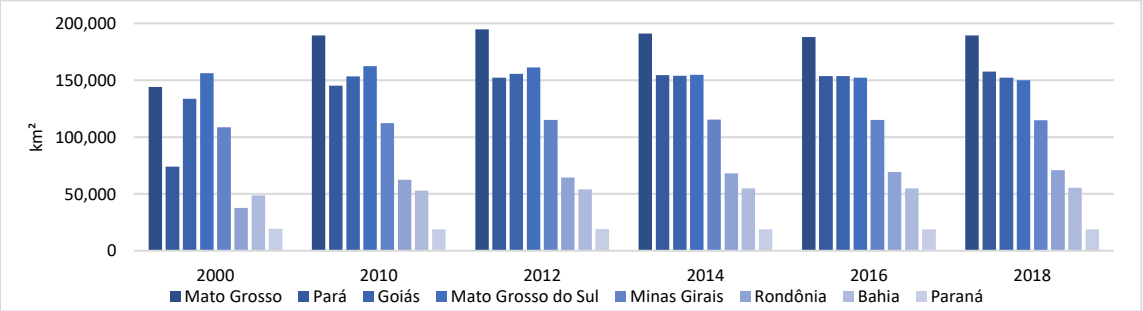


Cattle raising and pastureland follows similar trends in that major Amazon and Cerrado states make up a large portion of the area; but unlike cropland, pastureland has

[94] IBGE. 2020. Levantamento Sistemático da Produção Agrícola. *Brazilian Institute of Geography and Statistics.*
[95] Ibid.
[96] Ibid.
[97] IBGE, 2018.
[98] IBGE, 2020.

remained relatively stable since 2010 in its land use growth (the exception being Rondônia).

Figure 6: Use of Land – Managed Pasture Area[99]



To summarize, within the Amazon and Cerrado, there are key states that are historically important for crop and pastureland areas including Mato Grosso, Pará and Goiás. That said, other, smaller states have grown significantly over the last 20 to 30 years with implications for deforestation (Table 1). Supply has been a key element of deforestation trends; however, rapid demand growth is also important to consider.

Table 1: Compounded Annual Growth Rate[100]

	Cropland Area			**Managed Pasture Area**		
	2000-2010	**2010-2018**	**2018 Share**	**2000-2010**	**2010-2018**	**2018 Share**
Mato Grosso	3%	3%	18%	3%	0%	17%
Paraná	1%	0%	11%	0%	0%	2%
Goiás	2%	2%	10%	1%	0%	14%
Minas Girais	3%	2%	8%	0%	0%	10%
Mato Grosso do Sul	1%	4%	7%	0%	-1%	13%
Bahia	4%	3%	5%	1%	1%	5%
Pará	10%	16%	1%	7%	1%	14%
Rondônia	3%	9%	1%	5%	2%	6%
Total Brazil	**2%**	**2%**	**--**	**2%**	**0%**	**--**

Brazilian producers have taken advantage of rapidly rising soybean prices not only during the commodity supercycle of the 2000s but more recently as well (Table 2). Exports

[99] IBGE, 2018.
[100] IBGE, 2018.

multiplied more than six-fold between 1989 and 2019, in part because of the agriculture and agri-food industry, which now makes up 35% of total exports.[101] Soybeans and processed meat shipments multiplied by three and seven-fold within the same period, respectively, contributing to about half of agriculture and agri-food exports.[102] One view is that growth in Brazil's agriculture production, and related economic benefits, will partly depend on expanding into "new agriculture land."[103] And yet, that may not be necessary nor is it sustainable. Brazil was able to grow soybean and beef production during periods when deforestation rates steeply declined, particularly during the commodity boom, in part driven by yield increases (Table 2). Also, it is estimated that a depleted rainforest could represent up to US$8bn of annual economic revenue lost from tree-related activities that would require a preserved rainforest (e.g., harvesting nuts).[104] Agriculture development need not contribute to deforestation, and there can be economic benefits to reducing it.

[101] UN. 2020. UN Comtrade. *United Nations – Department of Economic and Social Affairs*.
[102] Ibid.
[103] OECD-FAO, 2019, p. 129.
[104] de Bolle, 2019, p. 5.

Table 2: Key Indicators[105]

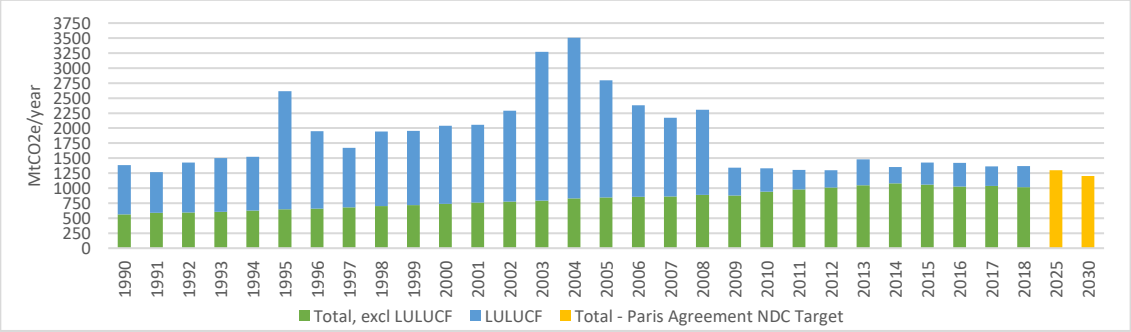
	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	5-yr CAGR	20-yr CAGR
Soybean Production (Thous.Tonnes)	**19,419**	**38,432**	**55,027**	**75,324**	**95,435**	**114,075**	**119,282**	**115,030**	**120,620**	**122,585**	**5%**	**6%**
Exports (Thous.Tonnes)	*3,736*	*16,219*	*24,020*	*33,301*	*50,307*	*67,549*	*72,939*	*65,247*	*71,940*	*72,957*	*8%*	*8%*
Area Harvested (Thous.Hectares)	*9,617*	*13,970*	*22,749*	*24,181*	*33,252*	*33,909*	*35,149*	*35,874*	*36,678*	*36,998*	*2%*	*5%*
Yield (Tonne/Hectare)	*2.0*	*2.8*	*2.4*	*3.1*	*2.9*	*3.4*	*3.4*	*3.2*	*3.3*	*3.3*	*3%*	*1%*
Brazil Soybean Prices *(Paraná State: US$/60Kg Bag)*	**--**	**10.5**	**12.9**	**22.8**	**20.6**	**22.3**	**20.8**	**21.5**	**19.0**	**25.9**	**5%**	**5%**
Beef and Veal Production (Thous.Tonnes)	**4,317**	**6,540**	**9,174**	**8,731**	**8,528**	**8,716**	**8,923**	**9,215**	**9,276**	**9,328**	**2%**	**2%**
Exports (Thous.Tonnes)	*122*	*313*	*1,306*	*1,399*	*1,280*	*1,286*	*1,430*	*1,689*	*1,711*	*1,953*	*9%*	*10%*
Cow Inventory (Thous)	*41,664*	*40,956*	*47,749*	*51,845*	*54,210*	*55,025*	*55,850*	*58,080*	*57,200*	*58,717*	*2%*	*2%*
GHG Emissions - Agriculture (Mil. Metric Tons CO2e)	**340**	**380**	**468**	**491**	**497**	**503**	**507**	**496**	**--**	**--**	**0%**	**6%**
Deforestation - Legal Amazon (km^2)	**13,730**	**18,226**	**19,014**	**5,820**	**5,814**	**7,005**	**6,671**	**7,033**	**10,666**	**10,313**	**12%**	**-3%**
Deforestation – Cerrado (km^2)	**--**	**--**	**17,613**	**9,994**	**11,675**	**6,790**	**7,312**	**6,634**	**6,483**	**7,340**	**-9%**	**--**

[105] Haver Analytics, 2021.

EMISSIONS AND DEFORESTATION

Brazil's climate policy and emissions reduction targets are closely linked to deforestation. Brazil's annual GHG emissions in 2017 reached 3.6 $MtCO_2e$ per capita, and in 2016, more than 500 $MtCO_2e$ (over 30% of total) could be attributed to the agriculture sector, topping the sector rankings.[106] Land use, land-use change, and forestry (LULUCF) accounted for around 60% of total emissions in 1990, dropping to its historical low of 20% by 2014 before rising again and settling at 27% in 2018.[107] As shown in Figure 7, Brazil's emissions reduction accelerated between 2004 and 2009; however, since 2010, Brazil's emissions reductions have stalled. Notwithstanding an insufficiently aggressive NDC, Brazil is on track to meet its emissions reduction targets as they include LULUCF.[108] At risk is Brazil's NDC deforestation target, which consists of: "1) zero illegal deforestation in the Brazilian Amazonia; 2) restoring and reforesting 12 million ha of forests by 2030; [and] 3) enhancing sustainable native forest management."[109] Without consistently reducing forest cover loss, Brazil is at risk of undoing vital climate action.

Figure 7: Greenhouse Gas Emissions including LULUCF – Historical and Target[110]

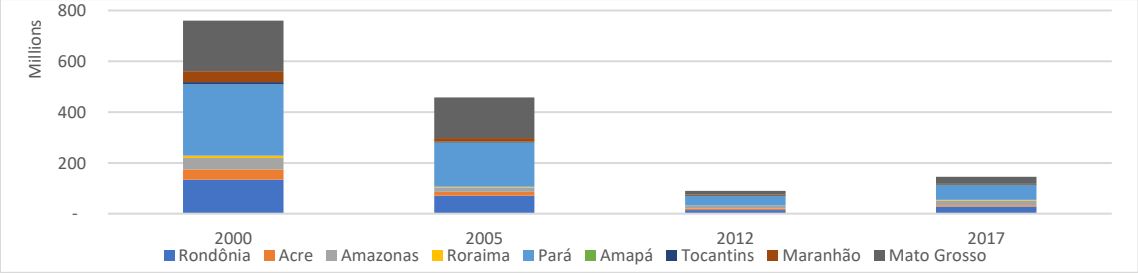


[106] Ritchie, Hannah and Max Roser. 2017. CO_2 and Greenhouse Gas Emissions. *Our World in Data.*
[107] Climate Action Tracker, 2020.
[108] While out of scope for this study, it is important to note that, generally, Paris Agreement NDC targets exclude LULUCF. However, in Brazil, they were included likely due to its importance and, as seen in historical data, non-LULUCF emissions have jumped. Ibid.
[109] Ibid.
[110] Ibid.

Emissions related to agriculture come from several avenues. Deforestation in Brazil contributed to a 2-5% increase in global carbon dioxide emissions on an annual basis between 1996 and 2005.[111] The use of fertilizer is necessary to improve yields and production, but its over- and misuse can increase not only the emission of nitrogen gas but also the contamination of water supply, putting biodiversity and food security at risk.[112] Transportation also contributes to rising emissions. Brazil exported approximately 77 million tons of soybean in 2018. Using Péra et al.'s assumptions that each ton amounts to 130.55 kg of CO_2 in transportation emissions, the movement of soybean exports contributed about 10 $MtCO_2$ to a total of 464 $MtCO_2$ produced in Brazil.[113] Assessing emissions throughout the entire agriculture supply chain would greatly improve Brazil's emissions reduction; however, there remains limited action around agriculture emissions outside of deforestation.

In the Amazonian states, emissions have fallen significantly from the highs of the 2000s, with Mato Grosso, Pará and Rondônia leading the reductions. By 2012, in line with the policy efforts mentioned, emissions dropped substantially. Unfortunately, those trends have started to reverse (Figure 8).

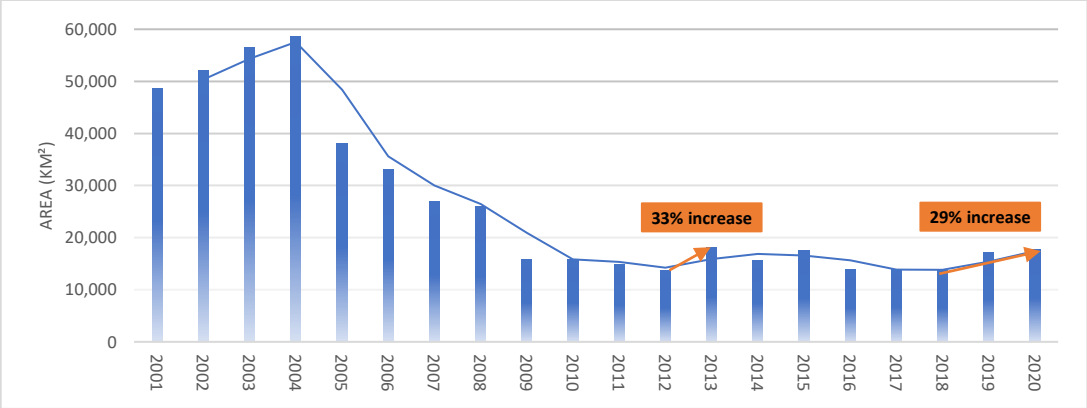
Figure 8: Emissions of CO_2, including deforestation, in Amazonian states[114]



[111] Magrin et al, 2014, pp. 1522
[112] Porter et al, 2014, pp. 164, 285
[113] Péra et al., 2019; Ritchie, Hannah and Max Roser, 2017.
[114] IPAM (2021). Carbon Calculator. Amazon Environmental Research Institute (IPAM).

As noted, Brazil's climate policy is highly centred around limiting deforestation. Combining climate vulnerability with rising emissions could exacerbate vulnerable conditions and increase the need to actively manage deforestation. Since its introduction in 2004, PPCDAm[115] was able to reduce deforestation rates significantly (Figure 9). Despite aggressive targets set in 2009, the country is once again experiencing a swift jump in deforestation. Specifically, the resurgence of deforestation reflects the unsustainably rapid rates of agriculture expansion in the Brazilian Amazon and Cerrado, in part because of illegal activity and lack of enforcement.[116]

Figure 9: Annual Deforestation Rates in Amazon and Cerrado[117]

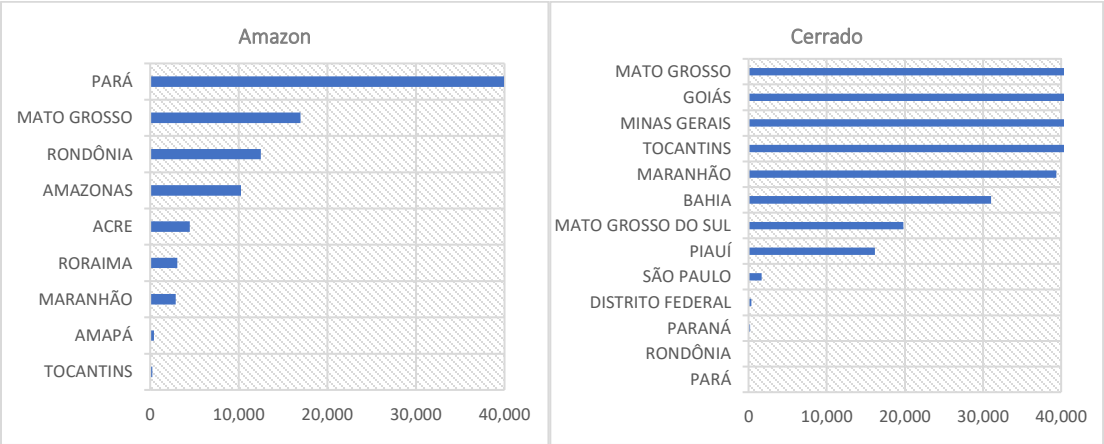


Brazil's North-East is particularly vulnerable to land degradation driven by climate change and human actions, including mismanagement of resources and deforestation.[118] Cumulative deforestation has devastated two of the most important agriculture producing states, where significant attention is being paid to sustainable agriculture: Pará and Mato

[115] The Action Plan for Prevention and Control of Brazilian Amazon Deforestation tracks deforestation rates. (The tracking was made possible through the partnership between NASA and Brazil's National Institute for Space Research (INPE) and the creation of the Real Time Detection of Deforestation (DETER) – satellite tracking and monitoring. Data is transmitted to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). INPE and IBAMA are the main Brazilian institutions involved in environmental and climate related endeavours.
[116] de Bolle, 2019, p. 6.
[117] PRODES (2021). *Deforestation Rates*. TerraBrasilis (Deforestation). Instituto Nacional de Pesquisas Espaciais.
[118] OECD-FAO, 2019, p. 104.

Grosso (Figure 10). Moreover, impacts are expanding into other biomes, including the wetlands of Pantanal, in part through a doubling of forest fires in 2020 relative to 2019.[119]

Figure 10: Total Deforested Area by State (km²)[120]

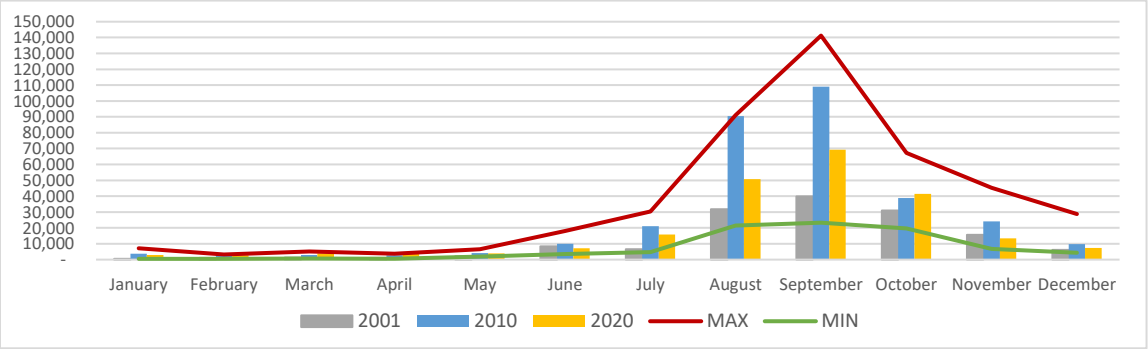


While some deforestation may be attributed to natural causes, man-made fires and slash and burn practices are increasingly common for rapid land clearance.[121] Also, climate change and rising temperatures increase water stress, lead to droughts and drier conditions, and potentially further contribute to forest fires.[122] Deforestation rates increased by 30% in the Legal Amazon in 2019 when Brazil faced one of its harshest burning seasons in recent history.[123] Despite assumptions that an unusually dry season led to the 2019 wildfire, deforestation was the predominant driver.[124] In 2020, Brazil's Amazon and Cerrado experienced another devastating year (Figure 11). Importantly, forest fires have the potential to rejuvenate soil; however, when done incorrectly and without the appropriate

[119] Wenzel, Fernanda, Naira Hofmeister, Pedro Papini. 2021. Demand for soy puts pressure on Pantanal, Brazil's largest wild wetland. *MONGABAY*. June 23; DETER, 2021.
[120] PRODES, 2021.
[121] de Bolle, 2019
[122] Andreoni, Manuela and Ernesto Londoño. 2021. Brazil, Besieged by Covid, Now Faces a Severe Drought. *New York Times*, June 19.
[123] PRODES, 2021.
[124] Alencar, Ane, Paulo Moutinho, Vera Arruda, Camila Balzani and João Ribeiro. 2019. Amazon Burning: Locating the Fires: Technical Memo from the Amazon Environmental Research Institute (IPAM). *Amazon Environmental Research Institute (IPAM).* September. p. 7

knowledge and tools, they can counteract sustainable agriculture and, in turn, climate adaptation. Ideally, "slash and burn" agriculture should be limited to smaller scale production in lower-density environments because of the soil's need to regenerate.[125] However, the rapidly expanding agriculture industry is contributing to an unsustainable escalation of the practice.

Figure 11: Monthly Forest Fires in Brazil (1999-2020)[126]

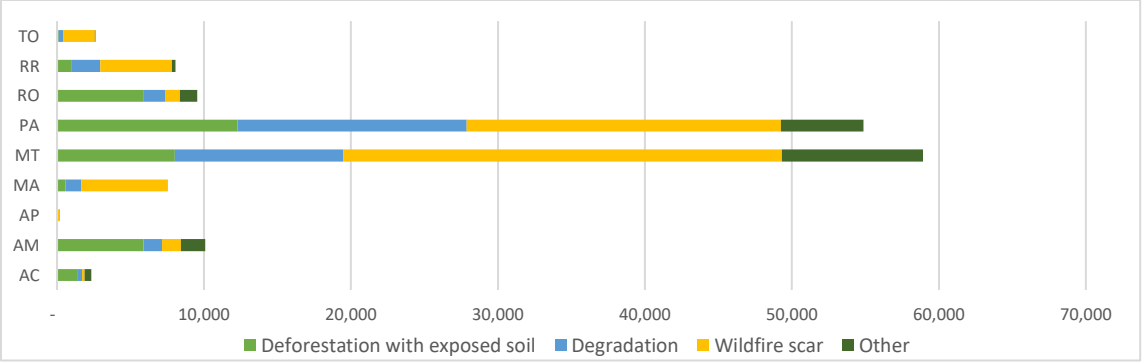


Another important signal that deforestation is not require for agriculture development is the substantial amount of degraded land – some of which could be rejuvenated and used for various activities (Figure 12). Brazilian company Suzano Pulp and Paper, for example, only plant on anthropogenically degraded land for its eucalyptus production and reforestation efforts. Despite the potential, there appear to be barriers to knowledge sharing and capacity building in terms of agriculture practices. The Intergovernmental Panel on Climate Change (IPCC) notes the heavy lifting required from the agriculture sector in eliminating deforestation by 2020, stating that either livestock production would have to drop by 26-40% by 2050 or average livestock density would need to double "from 0.74 to 1.46 head per hectare."[127] While not entirely impossible, accomplishing these targets would

[125] de Bolle, 2019.
[126] Quiemadas, 2020.
[127] Porter et al, 2014, p. 1521

require a significant shift in agriculture production practices. Agriculture production and trade, emissions reduction and deforestation limitations have had concurrent success in Brazil; however, policy implementation and taking a holistic approach must be central to climate action and environmental protection to sustain that success.

Figure 12: Cumulative Deforestation Notices by Legal Amazon State and Class (Aug 2015 - Dec 2020)[128]



SUSTAINABLE AGRICULTURE DEVELOPMENT[129]

The Paris Agreement's objective is to "enhance adaptive capacity, strengthen resilience, and reduce vulnerability to climate change. All Parties are required to engage in adaptation planning processes, such as National Adaptation Plans (NAPs), as well as in the implementation of adaptation actions (art. 7.9)."[130] For Brazil, its NAP lies within its NPCC and "brings together existing sectorial strategies which are considered relevant to the climate adaptation objectives" as it relates to land use and change.[131]

Brazil has developed a wide array of mitigating and adaptive measures within the IPCC's parameters. During periods of rapid agriculture expansion, namely mid-1990's to 2000's, the government promoted crop productivity (e.g., electrification leading to

[128] Deter, 2021.
[129] Further details provided in Appendix 3.
[130] Tigre, 2019, p. 412
[131] Milhorance and Bursztyn, 2019, p. 218-222

improved storage and irrigation capacity), technological improvements and heard density.[132] Moreover, Brazil boasts an internationally recognized reputation for developing adaptive technologies - such as GMO soybeans - allowing Brazil to expand its production in areas that would otherwise be inhospitable. As part of the NPCC and NAP, other practices were introduced in the 2000s; and in 2010, Plano (Plan) ABC launched and became core to the agriculture sector's response to climate change. Plano ABC is comprised of seven programmes: "namely recovery of degraded pastures, integration of crop-livestock-forest and agroforestry systems, no-tillage system, biological nitrogen fixation, planted forests, animal waste and adaptation to climate change."[133] Complementing the ABC plan are PPCDAm and PPCerrado, with a central objective related to deforestation. As part of the ABC Plan, the objective "is to improve efficiency in the use of natural resources, increase the resilience of production systems and rural communities, and allow the adaptation of the agricultural sector to climate change." Nevertheless, the success of the ABC Plan faces numerous obstacles including absence of direction, monitoring capacity and limited financial resources.[134] Also, it does not shield against illegal deforestation.

Brazil's size, geography, development levels and economic structure result in an exceptionally complex context, which is further challenged by climate change. Challenging sustainable development are Brazil's persistent security issues, such as comparatively high levels of criminal activity and violence.[135] Limited opportunities for employment outside

[132] Assunção, J., Ahmed Mushfiq Mobarak, Molly Lipscomb, and Dimitri Szerman. 2016. Working Paper: Agricultural Productivity and Deforestation in Brazil. *Climate Policy Initiative*. December: pp. 6-9.
[133] Milhorance and Bursztyn, 2019, p. 224
[134] Gallo and Albrecht, 2019, p. 130
[135] UNODC. 2019. Global Study on Homicide – Booklet 2: Homicide: extent, patterns, trends and criminal justice response. *United Nations Office on Drugs and Crime*. July.

of mining and agriculture increases the likelihood of turning to criminality for subsistence. Also, the Legal Amazon has been an especially challenging context for environmental and social protection activists, as well as non-titled land holders. Violent land disputes are a persistent problem in Brazil.[136] Most of the country's land disputes occur in the Legal Amazon.[137] "Squatters and invadors" are also very active in the Amazon, responsible for most illegal resource cultivation.[138] Of note, there is a growing link between squatters and invaders, and criminal organizations. Economic development has not only created "opportunities to legal deforestation, but also reduce[d] protected areas in rural properties…This shows how the legal and political arena in Brazil promotes the expansion of the agricultural frontier and the occupation of forestlands."[139] In this context of competing interests, remote areas are more often those facing higher rates of deforestation and receive the least support for adaptation.

FINANCIAL SUPPORT AND INCENTIVES[140]

Domestic channels for environmental and sustainable agriculture-linked credits are limited and complex reducing incentives to incorporate sustainable practices and actively contribute to climate targets.[141] As it stands, areas most affected by climate change and environmental degradation (North and North-East) are less integrated into the Brazilian financial system and have limited financial support to develop sustainable agriculture practices. Crop insurance is providing some reprieve, but adaptation requires funding.

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[136] Fetzer, Thiemo and Samuel Marden. 2017. Take What you Can: Property Rights, Contestability and Conflict. *The Economic Journal*, 127 (May): p. 758.
[137] Muñoz, César. 2019. Brazil's Amazon —and Its Defenders—Are Under Attack From Illegal Loggers. *Human Rights Watch.* November.
[138] de Bolle, 2019, p. 6
[139] Gallo and Albrecht, 2019, p. 134.
[140] Further details included in Appendix 3.
[141] World Bank, 2018.

Through a system of earmarking financial operations, subsidized funds are directed at priority sectors, mainly real estate and rural activities.[142] However, rural credits make up a mere 5% of total credit in Brazil.[143] Most earmarked rural credits go to farmers, but it is predominantly funnelled to the more developed South and Central-West regions of Brazil. This imbalance is in part due to environmental and land tenure challenges, most prevalent in the North and North-East of Brazil.[144] Connecting CAR (Rural Environmental Registry) with rural credit was a way to integrate, and possibly promote, environmental and agricultural policies in the Amazon region. However, it is challenging to assure "the effectiveness of this measure and promot[e] change in agricultural practices among all categories of producers."[145] For instance, ABC related credit lines, which promote climate mitigation and combat deforestation, make up less than 2% of the total rural credit, limiting the amount of credit available to priority areas in the Amazon.[146]

Sustainable agriculture promotion through "the low-carbon agriculture plan has offered financing for sustainable practices, but Brazilian farmers have not yet shown much inclination to take these loans."[147] One explanation for the lack of uptake is that "the progressive growth of the ABC interest rates, coupled with a low investment economic environment, negatively impacted the volume of disbursements, which was already insufficient, making the credit line uncompetitive in relation to traditional rural credit lines."[148] Also, ABC's technical requirements add additional barriers to access, making

[142] Ibid.
[143] Ibid.
[144] Ibid.
[145] Milhorance and Bursztyn, 2019, p. 224.
[146] Ibid.
[147] Eduardo & Franchini, 2014, p. 684.
[148] Milhorance and Bursztyn, 2019, p. 224.

them relatively uncompetitive related to traditional financing.[149] Lastly, the complexity of the funding options can be difficult to navigate. There are more than ten loan programs, bound by specific rules, with an approximately equal number of diverse lending sources with their own rules.[150]

Smaller scale farmers are in fact disadvantaged within this framework. In terms of scale of emissions reduction, smaller farms cannot compete with the reduction amounts of medium- and large-sized agriculture producers. Therefore, the smaller and family farms are more so supported through other programs, such as green credit lines from PRONAF, or more recently Plano Safra.[151] Again, while these establishments have access, the issue is scale: "major challenges remain in scaling-up access to credit that favours a change in agricultural practices, particularly that accessible to family farmers."[152] Technical requirements are indeed important; however, capacity building requires capital.

Central to climate finance and investment related to deforestation has been the REDD+ or ENREDD+ (Brazil's National Strategy on REDD+ established in 2013)[153], which provide the financial infrastructure to address deforestation and forest preservation.[154] Its main objective is to "mitigate GHG emissions by eliminating illegal deforestation, delivering environmental and co-benefits and promoting…the development of a low-carbon economy."[155] However, much like other programs, its effectiveness remains a question: "the total REDD+ investment has been 70 times smaller than the

[149] Ibid.
[150] Souza et al, 2020, p. 21.
[151] Ibid.; Souza et al., 2020, p. 20.
[152] Ibid., p. 225.
[153] Further details provided in Appendix 3.
[154] Gallo and Albrecht, p. 124.
[155] Ibid., p. 129.

subsidies provided to the agricultural sector in Brazil" and point to "the struggle of distinct but at the same time competing and coexistent discourses."[156]

Policies are in place, but institutions are weak. Command-and-control has worked in the past but incentives to continue this path are few. The economy needs to develop but options are sometimes limited, particularly in rural, remote areas such as the Amazon. Much like economic, environmental and climate policy needs to evolve; without this evolution Brazil will struggle to adapt and mitigate against climate change.

DISCUSSION

This paper's purpose was to better understand the intersection between environmental and climate policy and agriculture development. Brazil's mitigation and adaptation measures have been mostly centred on deforestation reduction because up until recently, deforestation reductions helped Brazil meet its climate targets. However, in line with the study's hypothesis, this trend is reversing, and economic priorities are overshadowing climate actions. As seen, deforestation is largest in some of the biggest agriculture producing states; and more recently, states experiencing rapid expansion (some from low levels) are also facing higher deforestation. However, this trend is counter to sustainable economic development.

The data showed that deforestation is impacted by two competing forces: environmental policy and economic development. Environmental protection is in turn combating climate adaptation and mitigation needs of its ecosystems through sustained declines in deforestation and, at the same time, an institutional framework that is based on a solid policy foundation but lacks a practical infrastructure. This is due to 1) lack of

[156] Ibid., p. 132.

environmental leadership; 2) constrained capacity both financial and technical (federal, state, sector, and civil society); and 3) limited connectivity amongst competing interests (public policy, socioeconomic development, and sector growth).

A leader can shift the environmental agenda. Bolsonaro rose to power as the economy struggled, poverty rates were rising, and a massive corruption scandal weakened faith in the country's institutions. Bolsonaro promised to spring Brazil back to recovery. Since Bolsonaro's administration took office, the agriculture sector and trade has been on a booming trend, but illegality and environmental degradation also rose. Early on in his term, Bolsonaro suggested to merge the agriculture and environment ministries in support of commoditizing the Amazon, reducing protection, and curtailing environmental activism.[157] During this time, the country is seeing rising forest fires, illegal deforestation and is confronted with its inability to fundamentally address deforestation, exacerbating precarity for Brazilians.

In theory, public policy should address these vulnerabilities, but priorities have tilted towards economic considerations over environmental protection and sustainable development; a sign that institutions are weaker than assumed. Thus far, environmental policy and agriculture development have mostly functioned in parallel with a few modest intersections; however, they must be effectively integrated to be successful in the current context, as well as reduce single-person dependence and outside influence.

Public investment is funneled to areas with agribusiness presence but without the integration of productive and social inclusion strategies, which leads to a narrowly defined development strategy.[158] In the end, public investment and provision of services are more

[157] Webb, 2018, p. 21.
[158] Milhorance and Bursztyn, 2019, p. 227.

so driven and stimulated by strategic sector opportunities rather than the socioeconomic needs of affected communities. Climate policy and adaptation strategies are facing a similar fate. Brazil is lagging on developing a more holistic, coordinated, adaptation strategy that integrates command-and-control with incentives. Brazil's institutions lack appropriate resourcing, are vulnerable to political influence, and its focus is often limited to the 4-year election cycle. Without a solid institutional infrastructure to effectively enforce a command-and-control approach on a consistent basis, irrespective of who is in office, Brazil has already lost half the battle. Add to this limited financial and economic incentives at all levels to incorporate sustainable agriculture practices into development, and the likelihood that Brazil will be able to reverse the environmental damage already done diminishes.

POLICY IMPLICATIONS

In the face of rising food demand and production, it is imperative to use all policy tools at our disposal to develop and implement a holistic and global approach to climate adaptation. The agriculture sector's economic importance highlights that international discourse, strong leadership and policies have the potential to greatly influence Brazil's approach to climate adaptation. In the absence of consistently effective institutions, strong monitoring and enforcement, Brazil's agricultural expansion has come at the cost of higher deforestation, forest degradation and in turn more precarious livelihoods. The sector's long-term sustainability is largely dependent on the strength of environmental policy but also its implementation and enforcement.

The coordination and connectivity between national and local levels of institutions as well as key stakeholders plays a significant role in whether policies and measures are

successfully developed and implemented. The reality is that climate change does not occur in a silo; it is interlinked throughout various ecosystems. Brazil needs to better integrate its sectoral strategies to ensure effective use of resources and maximize results. By integrating environmental and climate policy into economic sector strategies and policies, it can limit the ability to undo and weaken good policies namely strong data collection, land management and quantifiable targets. While further research is required to specifically determine policies options, integration strategies and the institutions to be made accountable, below are important elements central to the discussion.

Firstly, livelihoods should be at the centre of sustainable agriculture. Economic and politic crises ongoing since 2015 have led to a reduction in predictability and livelihood consistency. A severe recession in 2020 combined with rising deforestation pre-Covid-19 is expected to amplify the long-term impacts of deforestation on the Amazon's ecosystem. This trend entails increased misuse of land, mismanagement of resources and conflict over resources and land. Illegal use of land and criminal activity could increase if farmers are left out of the system and take the limited economic options they have. Domestic policy and international participation are required to support sustainable agriculture, knowledge sharing, capacity building and collaboration through effective incentive structures that are accessible.

Secondly, the private sector needs to be involved. Often, stakeholders in the fight against climate change are more represented by environmental groups and civil society than private sector companies. That said, in a globalized world, the importance of cooperation and collaboration with private sector companies is central to combating climate change. For example, Brazilian companies are starting to join in their opposition

to the government's inability to effectively manage deforestation. More recently, Brazil's JBS, the world's largest meat processing company by sales, has committed to enhance its supply chain monitoring and reporting to ensure cattle origins are not linked with deforestation.[159] Following JBS' commitment, a group of approximately "230 nongovernment organizations, companies and associations…called on the government of right-wing President Jair Bolsonaro [in September 2020] to take measures to combat rising deforestation."[160] Ideally companies and investors would have jumped on board before deforestation reached these renewed heights, but, unfortunately, companies often need to experience the financial benefit of doing so (or the cost of not) before acting when considering cost-benefit calculations. The reality is that there has been limited incentive for the very actors that contribute most heavily to climate change to be leaders in climate action. Financial institutions in Brazil are increasing their role but require better policy support on how to implement and technical support on to verify and monitor. Investors are pushing for companies to consider climate risks and act to reduce them. In some cases, companies are taking on the responsibility proactively but in others, it could simply result in greenwashing. For the most part, the cost-benefit does not appear to be there yet to take concrete, long-lasting action. Therefore, climate policy should be geared towards tilting the balance to demonstrate the benefits. This is no easy feat. The piece of the puzzle remaining is how do we get more of them on board?

Increasingly, major investors are placing environmental, social and governance (ESG) factors at a higher priority than previously when assessing investment appetite.

[159] Harris, Bryan. 2020. Brazil's JBS turns to blockchain to shine light on Amazon cattle supply. *Financial Times*. September 23.
[160] Figueiredo, Nayara. 2020. Soaring Amazon deforestation splits Brazil's agriculture lobby. *Reuters.* September 28.

Private and public companies are facing pressure to contribute to GHG reduction from shareholders and civil society. The 2020 Davos meetings demonstrated that the wave of discourse on companies' accountability is rising, and divestments are not entirely out of the realm of possibility.[161] Thus far, we've seen stark actions taken against the government and Brazilian agriculture and agri-food companies in opposition to ESG and climate change policies. For example, JBS was recently dumped from a major investment firm's portfolio due to the company's links to deforestation in the Amazon, as well as limited accountability for its supply chain management.[162] As noted above, JBS was quick to respond. These trends could mean that future investments will require significantly more due diligence around ESG factors. If done right, the change in how business and investment is done will have positive climate change effects. But, it is not yet clear what these added constraints could mean for local communities. Capital could become tighter or companies, including farmers, could face more stringent requirements. Financial access in remote areas is likely to remain a challenge. Big agriculture companies will have significantly more capacity to address their environmental impacts and incorporate climate change adaptation into the operations. Generally, pressure to incorporate stronger ESG policies and actions to incorporate climate change are disproportionately more challenging – leading to likely higher costs – in the developing countries than in the developed.[163] In the end, smaller operators will be disadvantaged in a competitive market, particularly if technical assistance is not provided. This is where the opportunity to coordinated policy arises.

[161] Tett, Gillian, Andrew Edgecliffe-Johnson & Billy Nauman. 2020. Davos 2020: Companies sign up to environmental disclosure scheme. *Financial Times.* January 22.
[162] Phillips, Dom. 2020. Investors drop Brazil meat giant JBS. *The Guardian.* July 28.
[163] Porter et al, 2014, p 949.

Future research could elaborate on targeted incentive structures that would stimulate sustainable development in remote locations where environmental policy enforcement is more challenging and security dynamics are risky. Further, deeper analysis of the influence trade policy and investment flows can have on climate change policy and adaptation could present options for private sector companies to take a more active role in climate change adaptation. A multidisciplinary approach that considers the diversity of stakeholders, drivers and impacts could present an effective strategy with innovative policy solutions.

LIMITATIONS

Data availability and frequency limited ability to conduct a thorough data and regression analysis to determine the quantifiable linkages between agriculture development and deforestation. Moreover, time constraints limited the study's assessment of other economic development policy, including those related to forestry. Lastly, incorporating state-specific policy could have narrowed the scope of this study, thereby providing insight into the influence state versus federal policy and its enforcement.

CONCLUSION

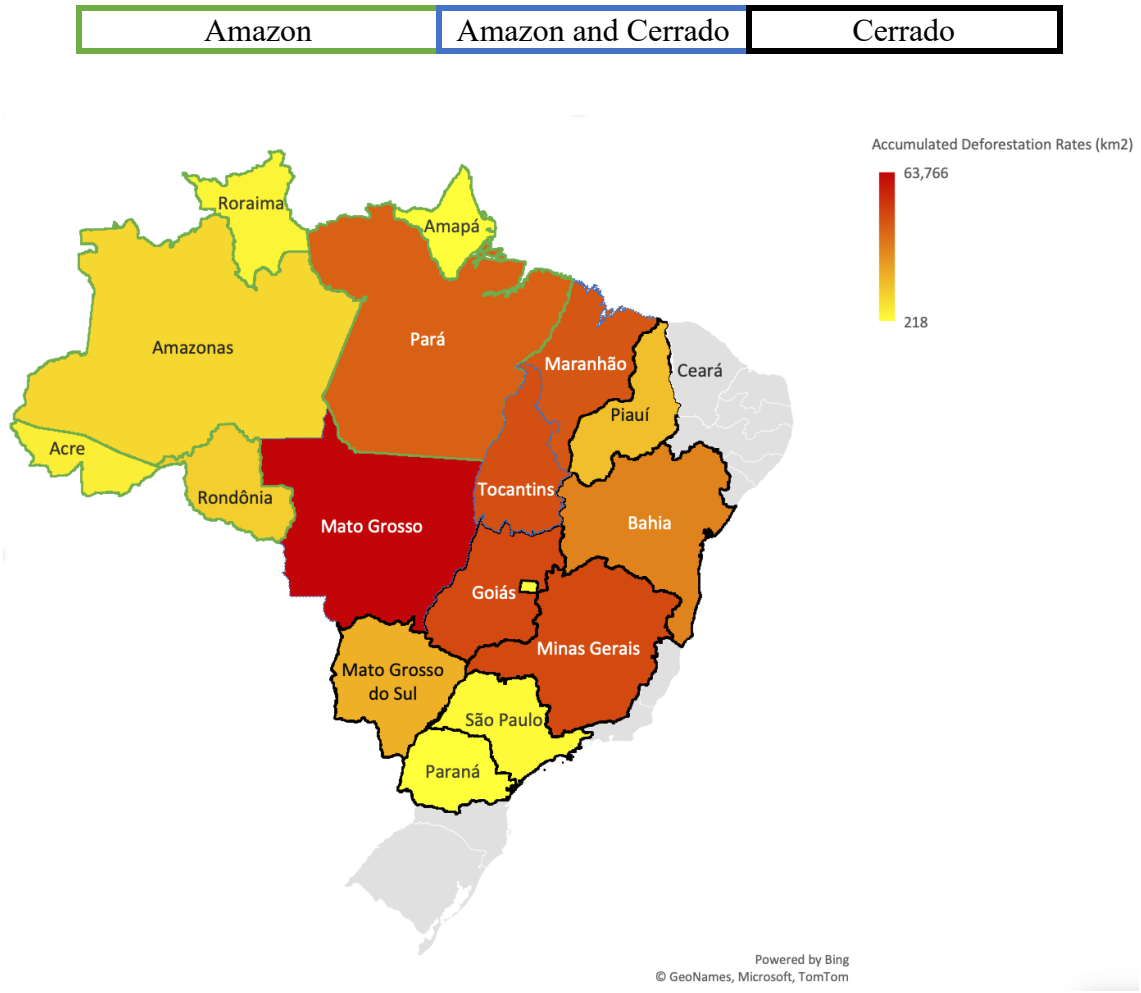
Brazil's role in the fight against climate change is unique. Brazil, as an agriculture powerhouse and home to an important carbon sink, is confronted with a massive challenge: taking advantage of economic benefits from rising international demand for food while incorporating climate adaptation and sustainable agriculture practices. This intersection is contributing to a complex challenge that is exacerbated by continuous economic declines, severe financial constraints and a national leader, Bolsonaro, creating a resurgence of anti-

environmental and pro-agribusiness rhetoric. The confluence of issues is exposing the fragility of Brazil's environmental and climate policy, and its institutions.

Relatively strong policies played an important role in curbing deforestation, until the early to mid-2010s. Since then, the rate in deforestation and environmental degradation has risen rapidly. Ecosystems, livelihoods and sustainability are at risk and could have long-term damaging effects on Brazil and global climate. As climate change puts the environment and natural capital at risk, strategic development of environmental and climate policies will become more important to ensure economic and political stability. However, policy does not exist in a vacuum. The linkages between economic development, agriculture development and climate change are inextricable. As such, all interested parties have a role to play in climate adaptation, including in the development and implementation of policies that both enforce and incentivize environmental protection. To address livelihood vulnerabilities and secure long-term prosperity, climate action cannot be siloed.

APPENDIX 1 – MAP OF BRAZIL

Figure 1 – Map of Brazil's States, (Legal) Amazon and Cerrado[164]



[164] PRODES, 2021. Legal Amazon consist of States corresponding to three regions making up 49% of Brazilian land. North: Roraima, Rondônia, Pará, Amazonas, Amapá, Acre, parts of Tocantins. North-East: parts of Maranhão. Centre-West: Mato Grosso. The Cerrado is the entirety of Distrito Federal (Brasilia) and parts of 11 states making up 24% of Brazilian land. North: Tocantins and Rondônia. North-East: Maranhão, Piauí, Bahia, Minas Gerais. Centre-West: Matto Grosso do Sul, Goiás, Mato Grosso. South-East: São Paulo. South: Paraná.

APPENDIX 2 - INSTITUTIONS

The institutional governance mechanisms within the NPCC – the guiding legal framework for climate action in Brazil – are the "Interministerial Committee on Climate Change (CIM) and its Executive Board (GEX); and the Interministerial Commission on Global Climate Change (CIMGC)" with several ministries playing key roles in climate policy formulation.[165] The MRE, Brazil's National Focal Point for the UNFCC biennial update reports, had been predominantly preoccupied with preserving a conservative climate policy stance which prioritized its alliance with BRICS countries (especially China), sovereignty over the Amazon, and championing to maintain the emissions headroom provided to emerging economics.[166] MCTIC leads the General Coordination on Climate (CGCL) communications to the UNFCC and chairs the Interministerial Commission on Global Climate Change (CIMGC) which is co-chaired by MMA. Eduardo & Franchini note that the MCTIC, despite its leadership role, has been "strongly influenced by the [MRE], and has therefore developed a position on climate change which is progressively inconsistent with the consensus of the national scientific community."[167] MAPA is also highly influential in Brazil. From 2010 onwards, MAPA headed a narrative centred on economic growth coming up against environmental considerations.

Despite the international context increasing MMA's involvement in national climate discussions, "it is believed that the MMA has less power than the MAPA and that the Ministry of Foreign Affairs has traditionally prioritised growth over conservation."[168] Notwithstanding, MMA is mandated to lead on environmental policy implementation and

[165] UNFCCC, 2019.
[166] Eduardo and Franchini, 2014, p. 680.
[167] Ibid.
[168] Gallo and Albrecht, 2019, p. 131.

"has historically been staffed by eco-minded individuals with a great interest in the environment and climate agendas."[169]

[169] Eduardo and Franchini, 2014, p. 680.

APPENDIX 3 – POLICIES

The IPCC has presented six climate change scenarios based on rising GHG emissions contributing to global warming. The IPCC's oft cited scenario stipulates that, under current conditions, global temperature is expected to increase by 1.5°C – inching towards 2°C – above pre-industrial levels between 2030 and 2052 and between 2°C to 4°C by 2080-2100.[170] Longer-term trends in temperature increases range depending on scenario characteristics (e.g. population growth, global integration etc…) with the high, most disastrous, case increasing by 6.4°C by 2090-2099 compared to 1980-1999.[171] The IPCC AR4 has outlined key adaptation actions that have the potential to enhance resilience in the agriculture sector. Porter et al. provide three primary adaptation objectives and related options: "(1) enhance drought and pest resistance through biotechnology and genetically modified crops; (2) provide financial safety nets for farmers to ensure continuation of farming enterprises through subsidized drought assistance and crop insurance; (3) maintain or enhance crop yields and suppress opportunistic agriculture pests and invasive species by increasing use of chemical fertilizer and pesticides."[172] Thus far, adaptation measures have been heavily geared towards early warning systems and "mostly address sectoral interests, such as agricultural practices (e.g., altering sowing times, crop cultivars and species, and irrigation and fertilizer control), public health measures for heat-related risks…, disaster

[170] IPCC. 2014. Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. *Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: p. 6.
[171] IPCC. 2007. Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. *Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: p. 13.
[172] Porter et al., p. 9116

risk reduction…, and water resources (e.g., supply and demand management)."[173] Due to the sectoral focus, socio-economic and livelihood considerations are often addressed through other development measures rather than incorporated into climate policy.

POLICIES AND ACTIONS PLANS

The inability to extrapolate with exactitude what is nature and what is anthropogenic challenges policymakers' ability to implement policies solutions based on their causes. In Brazil, climate change is inextricably linked with deforestation and in turn agriculture and trade policy. At the strategic level Brazil, the NPCC and the Forest Code are the foundational elements. At the "tactical–operational level, the plans against deforestation in the Brazilian biomes (PPCDAm and PPCerrado) are the main instruments for the integration and articulation of anti-deforestation initiatives, including REDD+. Both are focused on three areas: "territorial and tenure planning, monitoring and environmental control and incentives for sustainable production activities."[174] The following section will elaborate on these instruments and policies.

NATIONAL CLIMATE CHANGE POLICY

Brazil's response to international climate change dialogue was the establishment of the National Plan on Climate Change (NPCC), announced in 2008 at COP 14. Brazil voluntary targets aim to reduce GHG emissions by 36.1-38.9% below 2020 projections (3236 $MtCO_2e$) mostly the reduction of deforestation in the Amazon below the 1995-2005 average rate of 19,625 km^2 by 2017.[175] These voluntary international targets translated into compulsory domestic targets set out in national action plans (Figure 1).

[173] Porter et al., 2014, p. 876
[174] Gallo and Albrecht, 2019, p. 129.
[175] Gallo and Albrecht, 2019, p. 127.

Figure 1: Deforestation – Historical and Targets[176]

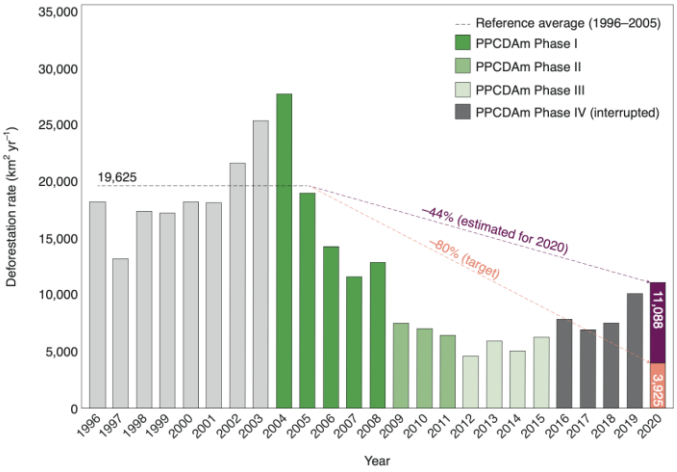
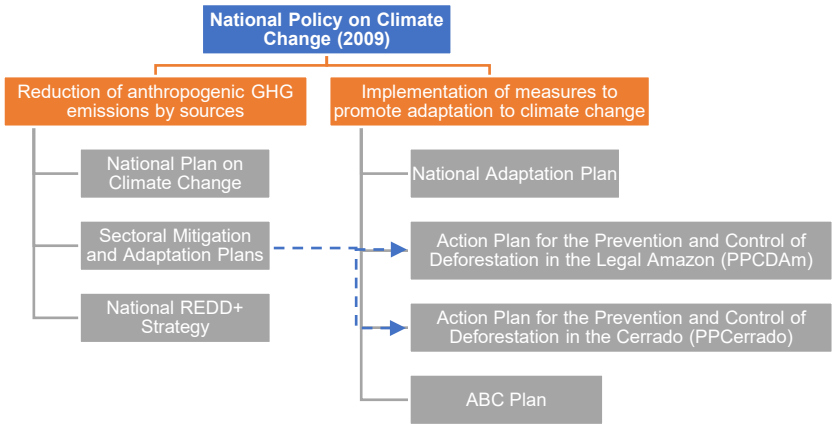


Fig. 1 | Deforestation on the rise. Official deforestation rates for the Brazilian Amazon, taken from PRODES[1]. The target 80% reduction from the 1996–2005 average is also shown. Bar colours represent phases of the Brazilian government's Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm).

Furthermore, the "NPCC is designed as an umbrella scope that includes sector-based plans for mitigation and adaptation to climate change (e.g. Low-carbon Agriculture Plan – ABC Plan) and the action plans for prevention and control of deforestation in biomes."[177] Figure 2 illustrates the various components to the NPCC.

Figure 2: National Policy on Climate Change components[178]



[176] Silva Junior, C.H.L., Ana C. M. Pessôa, Nathália S. Carvalho, João B. C. Reis, Liana O. Anderson & Luiz E. O. C. Aragão. 2020. The Brazilian Amazon deforestation rate in 2020 is the greatest of the decade. *Natural Ecology & Evolution*, 5: 144–145. December 21. p. 144.
[177] Ibid.
[178] Reformatted from UNFCCC, 2019, p. 7.

NATIONALLY DETERMINED CONTRIBUTION

Brazil joined the Paris Agreement in 2016, establishing its targets as part of the Nationally Determined Contribution (NDC) and "all policies, measures and actions to implement Brazil's NDC in the land-use scope derive from the NPCC, the 2012 Forest Code, the National System of Conservation Units Law and relevant mechanisms such as REDD+. In 2015, CONAREDD+ was created under the responsibility of MMA with the task of establishing ENREDD+ and formalized measures to reduce deforestation focusing the coordination of:

> "monitoring, finance and benefit-sharing systems, but it will be highly influenced by three thematic advisory boards based on three pillars for fostering a sustainable forest economy: (1) coordination of public policy on climate change and forests, (2) measurement, reporting and verification (MRV) of results and safeguards and (3) financing, fundraising and distribution of payments for REDD+ results."[179]

Brazil presents in its "NDC quantified targets for land-use change, agriculture and energy sectors."[180] Table 1 lists NDC's targets for LULUCF, Agriculture and Energy are by far the most concrete and aggressive, evidence that natural resource management are central to Brazil's climate policies.

Table 1 - Brazil's Nationally Determined Contributions[181]

Land use, land-use change, and forestry (LULUCF)	• Forest Code implementation and enforcement • Reduce illegal deforestation to zero in the Amazon until 2030 • Compensate emissions from legal deforestation until 2030 • Restore and reforest 12 million hectares of forests for multiple uses • Improve sustainable forest management measures
Agriculture	• Promote low-carbon agriculture • Restore 15 million hectares of degraded pasture areas and five million hectares of crop–livestock–forest integration system until 2030

[179] Gallo and Albrecht, 2019, p. 129.
[180] Ibid., p. 128.
[181] Reformatted from Gallo and Albrecht, 2019, p. 128.

Energy	• Increase the participation of sustainable biofuels to 18%, including increased participation of advanced biofuels • Achieve 45% of renewable energy sources, including the use of sources not limited to hydropower, biomass, solar and wind • Achieve 10% of energy efficiency in the generation of electricity by 2030 • Incentive actions that promote improvements on the public transportation sector
Industry	• Promote new patterns for clean technologies, which incentive energy efficiency • Adopt low-carbon infrastructure in the industrial sector
Transportation	• Promote efficiency measures • Improve infrastructure for transport and public transportation in urban areas

FOREST CODE

The Forest Code's success in greatly reducing deforestation rates in the early 2000's contributed to the view that Brazil could afford relaxing its policies, resulting in an updated Forest Code incorporating lobbied interests of the agribusiness complex.[182] Unfortunately, the 2012 Forest Code brought with it a "situation of extreme legal uncertainty and/or damage the flora and fauna" partly because of the challenging institutional framework surrounding land rights and titles.[183] The reformed code also produced a thwarted incentive structure.

The most significant changes to the Forest Code were the introduction of "new mechanisms such as the Environmental Reserve Quota (CRA) and the Rural Environmental Registry (CAR)."[184] CAR's served as "tradable legal title to areas with intact or regenerating native vegetation exceeding the Forest Code requirements" and the CRA as a form of surplus "on one property [that] may be used to offset a legal reserve debt

[182] Ibid., p. 126.
[183] Ibid., p. 126.
[184] Ibid., p. 126.

on another property within the same biome, and preferably, the same federal state."[185] The CAR is mandatory for all landowners and must clearly define the area and geographic coordinates, as well as include protected areas (including Permanent Protection Areas and Legal Reserves).[186] This information is accumulated into an electronic database that aids in controlling and monitoring rural properties by way of satellite imagery.[187] The Forest Code, in theory, is a mechanism to support the monitoring and reduction of deforestation as well as restoration of forests. However, enforcement is a challenge, particularly in remote areas, and contradicting targets and institutional overlap further slows execution.

To illustrate the contradiction, note that the "Forest Code calls for the recovery of 21 million hectares of natural vegetation" but this target is "much higher than the 12 million hectares of restored forests stated in the NDC" and provides a mechanism to circumvent restoration mandated by the NDC through "purchasing surplus compliance obligations from other properties."[188] This offsetting method to meet Forest Code and NDC targets "implies that the Forest Code goals could be achieved while still leaving a theoretical potential for legal clearing of 85 million hectares of forests...[and] allow[s] landowners with forest debt to purchase inexpensive offsets, while others could legally clear their own land."[189] Moreover, "the Forest Code relies strongly on the federal states and individual landowners to ensure its compliance and its success…[and] there are around 70 million hectares of undesignated public forestlands (for conservation or social use, for example) under no effective supervision" making these areas "a target of clandestine and illegal

[185] Ibid., p. 126.
[186] Ibid.
[187] Ibid.
[188] Ibid., p. 134.
[189] Ibid.

exploitation."[190] Practically speaking, the overlap and incentive structure might reduce the effectiveness and benefits from having these institutional frameworks in place. As such, there is significant pressure on Brazilian action plans to move the environmental agenda forward.

ACTION PLANS

Since their respective introductions in 2004 and 2010, the National Action Plan for the Prevention and Control of Deforestation and Forest Fire in the Amazon–PPCDAm[191] and the National Action Plan for the Prevention and Control of Deforestation and Forest Fire in the Cerrado–PPCerrado, were able to reduce deforestation rates significantly through pointed measures and targets. Again, measures in Brazil take the form of command-and-control over providing support for adaptation. Specifically, PPCDam's aim is to reduce deforestation through measures such as "sanctions on producers, increased enforcement of environmental laws, improved monitoring, establishment of new protected areas and incentives for zero-deforestation production practices."[192] Additionally, PPCDam included several mechanisms to control deforestation such as "a 'red list' of municipalities reflecting their deforestation rates restrained rural credit in these sites…[and] soy products trading companies began not funding or acquiring soybeans from deforested areas, establishing the Soy Moratorium in 2006" and the meat moratorium in 2009.[193] These moratoriums led to "a series of agreements between private firms, NGOs,

[190] Ibid.
[191] The tracking was made possible through the partnership between NASA and Brazil's National Institute for Space Research (INPE) and the creation of the Real Time Detection of Deforestation (DETER) – satellite tracking and monitoring of deforestation. Data is transmitted to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). INPE and IBAMA are the main Brazilian institutions involved in environmental and climate related endeavours.
[192] Milhorance and Bursztyn, 2019, p. 223.
[193] Milhorance and Bursztyn, 2019, p. 223.

and the government that banned the commercialization of soy and meat coming from illegally deforested areas."[194]

In terms of targets for the Amazon, they consisted of an 80% reduction of deforestation (primary objective of the PPCDAm), translating into a 55% cut in emissions by 2020.[195] Similarly, for the Cerrado, targets were set at a 40% of decrease in the deforestation rates (primary objective of the PPCerrado). Eduardo & Franchini highlight the noteworthy declines in deforestation which "reduced Brazilian GHG emissions by approximately 25–30% between 2005 and 2009, and owes its success to several factors including enhanced institutional capacity, the designation of protected areas and greater public awareness.[196] Despite aggressive targets and temporary successes in reducing deforestation rates, Brazil is once again experiencing a jump in deforestation reaching 10,896 km^2 in the Amazon and 6,483 km^2 in the Cerrado in 2019[197]; much of which could be considered illegal in major agriculture producing states such as Mato Grosso.[198] Regrettably, history has shown that competing economic interests may be a tough barrier to overcome.

REDD+

At REDD+'s core are national funds including the Amazon Fund (2008) and the National Climate Change Fund, or Climate Fund (2009). The Climate Fund, "linked to the MMA[,]…guarantee[s] resources to finance actions that aim to mitigate climate change" and specific to forests, "mainly supports activities intended for improving the efficiency

[194] Eduardo & Franchini, 2014, p. 683.
[195] Gallo and Albrecht, 2019, p. 127.
[196] Eduardo and Franchini, 2014, p. 681.
[197] Using 2019 data to link to next citation. PRODES, 2021.
[198] Milhorance and Bursztyn, 2019, p. 224.

and sustainability of the production of charcoal and fostering sustainable forest management."[199] The Amazon Fund, on the other hand, is an accredited entity able to receive funding from the Green Climate Fund (GFC), a priority funding institution for climate adaptation. The Amazon Fund is managed by the Brazilian Development Bank (BNDES), functions on "a payment-for-performance fundraising model…to support conservation and contribute to GHG emission reductions in the Amazon biome," and is closely connected to PPCDAm.[200] Yet, funding is limited: "the Amazon Fund has raised only 5% of the potential generated by REDD+ [and]…is up to date the only accredited entity."[201] While the Amazon Fund's mandate was extended to December 2021 in the face of rising deforestation rates, allocations were diminished due to poor performance and shifting political landscape in 2017.[202]

[199] Gallo and Albrecht, 2019, p. 130.
[200] Gallo and Albrecht, 2019, p. 127
[201] Ibid., p. 130
[202] Ibid., p. 130

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SKILLS & COMPENTENCIES

- English, French and Spanish written and spoken fluently
- Effective communication and writing skills, with an ability to succinctly capture complex arguments and concepts, to all levels of management and external stakeholders
- Customer-oriented approach focused on high quality output and support
- Ability to tackle diverse demands in a fast-paced environment
- Efficient and collaborative problem-solving skills with a focus on teamwork
- Advanced analytical skills, quantitative analysis and forecasting capabilities
- Comprehensive knowledge and skills using Microsoft Office (Word, Excel, PowerPoint, Access and Outlook), specifically strong knowledge of Excel and its capabilities
- Proficient with database products such as Oxford Economics, Haver and Bloomberg
- Enhanced experience using Tableau to visualise data and storyboards
- Forward-thinking leadership skills in project management, strategy, and hiring and coaching junior staff

PROFRESSIONAL EXPERIENCE

Principal Economist and Country Risk Analyst (Level 5), **Export Development Canada and FinDev Canada**
May 2010 to Present

- Lead economist and country risk analyst for the South American region responsible for country ratings, macroeconomic research, analysis and forecasting in areas such as sustainable finance, climate and sovereign risk, local sector dynamics, and socioeconomic conditions as they affect to Canadian trade and business interests abroad and FinDev Canada development investments
- Lead analyst for the agriculture sector responsible for risk assessments, forecasting, research and analysis in areas of environmental and climate change impact, sustainability, development in Canada and internationally
- Lead economist responsible for investigating and incorporating climate change into country and sector risk analysis
- Represent EDC as a subject matter expert on panels, webinars and external media.
- Produce briefings, recommendations and knowledge content on sector and country developments to management and senior leadership as well as external audiences to support business decisions (e.g. agriculture sector in Brazil and Canada, renewable energy in Argentina)
- Represent EDC when meeting with Canadian and foreign companies, international government officials, international organization (e.g. International Monetary Fund and Organization for Economic Cooperation and Development Country Risk Experts)
- Proactively work in close collaboration with internal stakeholders to ensure a unified strategic approach to risk and opportunities (e.g. collaborated on re-entry strategy for Argentina with EDC's Global Business Development Group for Senior Executive approval by defining sectors of opportunity)
- Led EDC's Country Risk Rating Committee - the approving body for EDC's country risk ratings – including leading, managing and contributing to quantitative model development and research into emerging country risk trends (e.g. COVID-19 impact on sovereign liquidity and solvency, hurricane clauses in sovereign bonds and their impact on lending) and collaborating with quantitative analysts to develop and evolve country risk models and data
- Led EPIC's Knowledge Content Committee developing and producing country and sector risk/opportunities content for internal and external audiences, including Canadian export diversification efforts (e.g. led development of export forecast model supporting the Global Export Forecast)

- Responsible for hiring, onboarding, coaching and mentoring economists (Level 3) in addition to leading team-wide learning and development plans
- Founding member of the LGBTQ2+ Resource Group responsible for developing and implementing strategic priorities to support EDC's Inclusion, Diversity and Equity plan

VOLUNTEER EXPERIENCE

Communications, Marketing and Strategic Advisor, CARE Morocco (non-profit organization)
October 2015 to February 2016

- Completed first draft of CARE Morocco's strategic financial business plan including key performance indicators, a financial model, strategic initiatives and scenario-based forecasting used to prepare CARE Morocco for financial sustainability and independence
- Created, in partnership with technical consultants, a new website for CARE Morocco
- Implemented a strategic communications and marketing plan including guidelines and processes
- Developed new communication tools

EDUCATION & TRAINING

- Master of Arts in **Global Security Studies – Environment and Energy Studies**, Krieger School of Arts and Sciences, Advanced Academic Programs, Johns Hopkins University (expected graduation August 2021)
    - Specific focus on climate change, sustainable finance, and agriculture in South America
    - Relevant courses taken: Climate Risk & the Economy, Energy & Climate Finance, Climate Change & National Security, Climate Change on the Front Lines, Sustainable Food Systems
- Faculty of Social Sciences, Honours Bachelor of Arts, Specialization in **Economics**, University of Ottawa (completed 2015)
- Completed Export Development Canada's **Emerging Leaders Program** (15 months)
- Completed **Unconventional Oil & Gas** 101 seminar
- Completed Statistics Canada **National Accounts** workshop
- Completed Moody's Introduction **Public Finance** course
- Completed Algonquin College's **Managing Multiple Priorities**
- Completed Fitch's **Systemic Risk and the Banking System**
- Completed Fitch's **Early Warning Signals in Banks**

PUBLICATIONS AND MULTIMEDIA

- Sustainable agriculture production key for Canada
- COVID-19: Canada's agri-food sector yields strong results despite pandemic
- 3 markets to watch in Latin America: Chile, Colombia and Ecuador
- Helping to make sense of uncertainty
- What happened in 2018 and what can we learn for 2019
- Managing the risks of doing business outside of Canada
- Risky business? Mitigate economic, political and social risks
- Gardella: A coming-out journey of self-awareness and success